International Journal of Food, Nutrition and Dietetics

International Journal of Food, Nutrition & Dietetics (IJFND) (pISSN 2322-0775; eISSN: 2455-569X), a broad-based peer-reviewed journal publish the most exciting researches with respect to the subjects of nutrition and food sciences. The journal covers current thinking on food and nutrition emphasizing the practical and social application of ideas. Special editions focusing on topics including micronutrients, special diets for management of health problems and cost sector catering provide readable content that is an invaluable resource for practitioners and academics wishing to inform themselves, their colleagues, or the public on modern thinking, research, and attitudes to food and nutrition.

Readership: Academics and researchers in the field, Dietitians, Food company managers, Food research institutes, Health care professionals, Nutritionists

Indexing Information: Index Copernicus, Poland; ProQuest, USA; Genamics JournalSeek; CiteFactor, USA; Cosmos Impact Factor, Germany etc.

For all other quiries Red Flower Publication Pvt. Ltd., 48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi - 110 091 (India), Phone: 91-11-22754205, Fax: 91-11-22754205, E-mail: info@rfppl.co.in, Web:www.rfppl.co.in

Printed at Saujanya Printing Press, D-47, Okhla Industrial Area, Phase-1, New Delhi - 110 020.

International Journal of Food, Nutrition & Dietetics (IJFND) (pISSN: 2322-0775, eISSN: 2455-569X), a broad-based peer-reviewed journal publish the most exciting researches with respect to the subjects of nutrition and food sciences. The journal covers current thinking on food and nutrition emphasizing the practical and social application of ideas. Special editions focusing on topics including micronutrients, special diets for management of health problems and cost sector catering provide readable content that is an invaluable resource for practitioners and academics wishing to inform themselves, their colleagues, or the public on modern thinking, research, and attitudes to food and nutrition.

Readership: Academics and researchers in the field, Dietitians, Food company managers, Food research institutes, Health care professionals, Nutritionists

Indexing Information: Index Copernicus, Poland; ProQuest, USA; Genamics JournalSeek; CiteFactor, USA; Cosmos Impact Factor, Germany etc.

Subscription Information

India
Institutional (1 year) (Print+Online): INR 5000

Rest of the World
Insitutional (1 year) (Print+Online): USD357

Payment instructions
Online payment link:
http://rfppl.co.in/payment.php?mid=15

Cheque/DD:
Please send the US dollar check from outside India and INR check from India made. Payable to 'Red Flower Publication Private Limited'. Drawn on Delhi branch

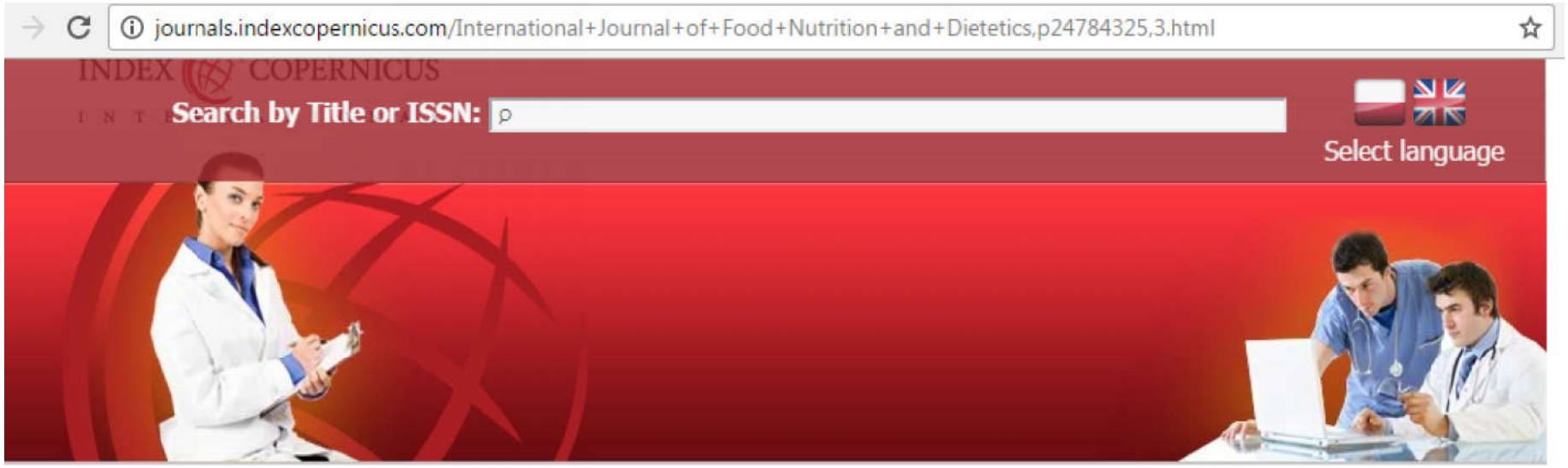
Wire transfer/NEFT/RTGS:
Complete Bank Account No. 604320110000467
Beneficiary Name: Red Flower Publication Pvt. Ltd.
Bank & Branch Name: Bank of India; Mayur Vihar
MICR Code: 110013045
Branch Code: 6043
IFSC Code: BKID0006043 (used for RTGS and NEFT transactions)
Swift Code: BKIDINBBDOS

Send all Orders to: Subscription and Marketing Manager, Red Flower Publication Pvt. Ltd., 48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi - 110 091(India), Phone: 91-11-45796900, 22754205, 22756995, E-mail: sales@rfppl.co.in, Website: www.rfppl.co.in

International Journal of Food, Nutrition and Dietetics

Volume 5 Number 2
May - August 2017

Contents



ICI Journals Master List 2014

Now available! **Annual Report ICI Journals Master List 2014** summarizing the 2014 year with full list of journals and publishers from database of Index Copernicus.

Index Copernicus Search Articles

Log in
to international indexing database ICI Journals Master List

Register journal
in an international indexing database ICI Journals Master List

Home ⇒ Journal passport ⇒

International Journal of Food, Nutrition and Dietetics [IJFND]

ISSN:
2322-0775, 2455-569X

ICV 2015: 68.67

No historical ratings

Area: Technical science

Print version: yes

Electronic version: yes

The journal is indexed in:

EBSCO, Genamics, Google Scholar

Original Article

International Journal of Food, Nutrition and Dietetics
Volume 5 Number 2, May - August 2017
DOI: http://dx.doi.org/10.21088/ijfnd.2322.0775.5217.1

Prevalence of Anemia in Pregnant Women w.s.r.t. Socio-economic Status: Observational Study

Sanjeev S. Tonni*, Anita C., Hemalatha M.S.**, Amrutha Kalyani*****

Abstract

Anaemia is defined as the condition in which there is a reduction in the concentration of hemoglobin in the blood stream to a level below 11%gm for pregnant women [1,2]. 40% of all maternal peri-natal deaths are linked to anaemia [3]. In India, up to 88% of pregnant women are affected [4]. Anaemia in pregnancy, particularly iron deficiency is a prominent problem in developing countries. A high prevalence of anemia in pregnancy was observed (96.5%) of which 22.8% had mild, 50.9% had moderate & 22.8% had severe anaemia in a study conducted in Delhi [5,6]. The consequences of anaemia for women include increased risk for low birth weight or prematurity, peri-natal & neonatal mortality, inadequate iron stores for the new born, increased risk of maternal morbidity & mortality & lowered physical activity, mental concentration & productivity [8]. The study was an observational study which comprised of 100 pregnant woman of age between 18 to 40 years attending the ante-natal care unit (Prasooti & Streeroga OPD) at K.L.E Society's Ayurveda Hospital, Shahapur, Belagavi being diagnosed as anemic as per Hb value, irrespective of caste, religion, socio-economic status& who gave consent were included in the study. The subjects suffering from any chronic illnesses, bleeding disorders, tuberculosis & other immunological diseases were excluded from the study. Chi square test was used to test the significance of the data. The study revealed that, health services were available and accessible in general, but a major constraint was that the people could not afford to utilise it, because of the quality of the service, delivered - there was poor quality awareness of women about the health services. The prevalence was higher in poorly educated women, women with large family size, and those who do not use family planning services.

Introduction

Anaemia is a late manifestation of deficiency of nutrient(s) needed for hemoglobin synthesis. Most of the anaemia are due to inadequate supply of nutrients like iron, folic acid & Vit-B_{12}, protein, amino acid, Vit-A, C & vitamins of B-complex group ie, Niacin & pantothenic acid are also involved in the maintenance of hemoglobin level [8]. In recent years, the contribution of B_{12} deficiency has been highlighted [9]. In India, the prevalence of anaemia is high because of low dietary intake, poor iron & folic acid intake, poor bio-availability of iron in phytate & fibre rich Indian diet & chronic blood loss due to infection such as malaria & hook worm infestation [10,11]. Anaemia gets aggravated by increased requirements during adolescents & during pregnancy [12]. However iron stores in these neonates are low, iron contents in breast milk in anemic women is low because of these factors substantial proportion of infants become anemic by 6 months [13]. Thus maternal iron deficiency and anaemia rendered the offspring vulnerable for developing iron deficiency & anaemia right from infancy [14]. Most of the studies suggest that a fall in maternal hemoglobin below 11gm /Dl is associated with a significant rise in perinatal mortality rate [15,16]. Women with moderate anaemia have substantial reduction in work capacity & find it difficult to cope with household chores & child care. They are more susceptible to infection and recovery

Author's Affiliation: *Associate Professor, *** Final year PG Scholar, Dept of PG studies in Swasthavritta and Yoga, KLE University's Shri B.M. Kankanwadi Ayurvedic Mahavidyalaya, Belagavi, Karnataka, India. **Associate professor, Department of Studies in Food Science and Nutrition, KSOU, Muktagangotri, Mysuru, Karnataka,India

Corresponding Author: Sanjeev S. Tonni, Associate Professor and HOD, Department of Swasthavritta & Yoga, K.L.E.University's Shri B.M. Kankanawadi Ayurveda College, Shahpur, Belagavi, Karnataka 590005, India.
E-mail: amrutha.kalyani@gmail.com

Recieved on 06.05.2017, **Accepted on** 16.05.2017

from infection may be prolonged [17]. Women with severe anaemia have higher maternal mortality rates when Hb level fall below 5gm/Dl.In urban primary health care institutions, it is possible to screen pregnant women for anaemia, identify those with Hb between 5.0 and 7.9 g/dl and give them in therapy as outpatients. Anaemia in pregnancy is associated with adverse consequences both for the mother and the foetus [15,16]. Effective implementation of the Tenth Plan strategies for combating anaemia can go a long way in reducing the short- and long- term adverse consequences of anaemia [16,17]. Hence the aim of this study was to identify the prevalence of anaemia among pregnant women in relation with their Socio-economic status.

Material and Methods

Setting of the Study

K.L.E Society's Ayurveda Hospital, Belagavi.

Study Population

Pregnant woman attending ante-natal care unit (Prasooti & Streeroga OPD) at K.L.E Society's Ayurveda hospital, Shahapur, Belagavi.

Sample Size

100

Study Design

Observational Study.

Inclusion Criteria

The pregnant women of age between 18 to 40 years of age who were diagnosed as anemic as per Hb value, irrespective of caste, religion, socio-economic status & who gave consent were included in the study.

Exclusion Criteria

The pregnant women with the age less than 18 years & more than 40yrs & those who were suffering from any chronic illnesses, bleeding disorders, tuberculosis & other immunological diseases were excluded from the study.

Study Period

The total study period was 3-4 months ie, from June 2015 to September 2015.

Source of Funding: Nil

Source of Conflict: Nil

Laboratory Investigation

Haemoglobin estimation, Pregnant women with a hemoglobin level less than 11g/dl and non-pregnant women with a level less than 12g/dl are considered anemic (WHO, 2001; WHO, 2006).

WHO (2000) has defined anemia as mild, moderate, or severe based on the following cut-off values (g/dl) for hemoglobin level [59].

	Mild*	Moderate	Severe
Pregnant	10-10.9	7.0-9.9	<7.0
Non-pregnant	11-11.9	8.0-10.9	<8.0

*The level of anemia termed 'mild' is still a serious condition given iron deficiency is already advanced by the time anemia is detected and deficiency can have functional consequences even when anemia is not clinically apparent (WHO, 2006).

Statistical Analysis

Relevant statistical test were applied to analyze the relation between Socio-Economic Status & Anemia in pregnancy.

Data Collection

A study proforma was used to collect the required data & information. In this study all questions were answered with full consent of respondents. Subjects were interviewed at the ante-natal OPD regarding demographic & socio-economic characteristics & pregnancy history. The hemoglobin estimation of these women was done by Sahli's method. Anemia was classified as per WHO criteria. The data obtained was tabulated using MS EXCEL. Frequency distribution, Percentages, mean, standard deviation& averages were used to present the data. Chi square test was used to test the significance of the data.

Results

Table 1: Age distribution of mothers

Age	Number (percentage)
18-25yrs	(65%)
26-35yrs	(22%)
36-40yrs	(13%)

As shown in Table 1, women differed in their ages from very young mothers (18-25 years old) to peri-menopausal women (40 years old). The majority of the mothers were in the age range of 18-25 years old (65%) which reflects the traditional marriage age of women in the province. Mothers of age range of 26-35 years old & 36-40yrs represented percentages of 22% and 13% of the examined mothers, respectively.

Religion

In this study, a maximum of 71% of patients were Hindu, 20% of patients were Muslims, 4% were Christians & 5% were belongs to other religions.

Table 2: Table showing of populations of pregnant women according to Religion

Religion	Number (Percentage)
Hindu	(71%)
Muslim	(20%)
Christian	(4%)
Others	(5%)

Occupation

In the study group of 100 patients, 32% were working while 68% were housewives.

Area

Among 100 patients, 28% were from rural &72% were from urban area.

Table 3: Occupations in pregnant women

Occupation	Number (percentage)
Working	(32%)
Housewives	(68%)

Table 4: Area wise distribution of pregnant women

Area	Number (percentage)
Rural	(28%)
Urban	(72%)

Education Level of Mothers and Husbands

Table 5: Educational levels of pregnant women

Parameter	Number (percentage)	
Educational level	Women	Men (Husbands)
Illiterate	(2%)	(3%)
Primary	(5%)	(7%)
Secondary	(19%)	(11%)
University	(66%)	(69%)
Postgraduate	(8%)	(10%)

Table (V) demonstrate the percentage of women and their husbands receiving different levels of education. The most interesting notice that from these data is the fact that about 2% of women and 3% of their husbands were illiterate without any level of education which represents an obstacle for health-improvement programs. Moreover, about 66% of women and 69% of husbands were under university education level meaning that the majority of women and their husbands was either illiterate or just receiving secondary and primary educations.

In addition, women receiving postgraduate education was only 8%; meanwhile husbands entered this high level of education was 10%. Indeed, these unoptimistic figures indicated that hindered features could be expected from the examined society as will be explained later in the association section between education and presence of anaemia. At the same time maternal education had a significant influence on nutritional status.

Effect of Age and Education Level

Table 6: Influences of age & education on anemia level on pregnant women

Terms of influence	Percentage of women with anemia					
	Normal >11.0g/dl	Mild anemia11.0 – 9 g/dl	Moderate Anemia 9.0 – 7.0 g/dl	Severe anemia 7.0 - 4.0 g/dl	Very severe anemia< 4.0 g/dl	Total no(n=100)
Age						
18-25yrs	-	-	24	-	-	24
26-35yrs	-	18	-	-	32	50
36-40yrs	-	-	-	26	-	26
Total	-	-	-	-	-	100
Women education						
Illiterate	-	-	-	-	28	28
Primary	-	-	-	23	-	23
Secondary	-	-	22	-	-	22
University	-	15	-	-	-	15
Postgraduate	-	12	-	-	-	12
Husband education						
Illiterate	-	-	-	-	26	26
Primary	-	-	-	23	-	23
Secondary	-	-	20	-	-	20
University	-	18	-	-	-	18
Postgraduate	-	13	-	-	-	13

Table 6 shows anaemia levels among the interviewed women aged from 18 to 40 years old. The level of anaemia was very severe in about 32% of women, while 18% and 24% had a mild and a moderate level of anaemia and 26 % of the examined women had severe level of anaemia, respectively. Statistical analysis indicated that age was strongly associated with anaemia levels and it was inversely related to the presence of anaemia with older women being somewhat more likely to be moderately or severely anemic than younger women. For instance, women older than 35 years old (in the age category of 36-40 yrs) were all suffering from anaemia from mild to very severe conditions. Strictly speaking, the rate of severe and very severe anaemia condition among women aged 36-40 years was almost five times as high as among women age 18-25 years. On the other hand, As shown in the second part of Table 6, about 28% of the illiterate women had anaemia from mild to very severe levels with about 23% having anaemia from moderate to very severe level. Women with a higher education are less frequently anemic than illiterate women or women with a primary or secondary education. Surprisingly, 12% women who had postgraduate study was suffering from mild level of anaemia but this could be attributed to some other factors not to her educational level. In spite of this misleading result, women with university, secondary and primary educations had moderate to very severe level of anaemia of 15, 22, 23% respectively indicating that when the women were well educated the anaemia level reduced significantly. Now, the question that should be investigated is that whether the husband education also affects the anaemia level of the interviewed women or not. The third part of Table 6 has the answer of this question. In general, husband education has a significant effect on anaemia level of the interviewed women. About 26% of illiterate husband their wives had anaemia from mild to very severe conditions. On the contrary, educated wives of highly educated husband had a lower rate of anaemia. Wives of husbands with postgraduate education had the lowest level of anaemia.

Types of Mothers' Diet

As exposed, in Table 7, the majority of the mothers had a poor diet (36%) or a very poor diet (40%) indicating the very poor nutritional conditions of the interviewed mothers. Some factors influencing pregnancy outcomes 24% of the studied women knew the right types of foods they were supposed to eat during pregnancy.

Table 6: Types of diet in pregnant women

Diet	Number (percentage)
Adequate	(24%)
Poor	(36%)
Very poor	(40%)

Percentages of Folic Acid Intake by Mothers

Table 7: Folic acid intake in pregnant women

Folic acid intake	Number (percentage)
Positive	(82%)
Negative	(18%)

The percentage of mothers who were practicing folic acid intake during their pregnancy stage is shown in Table 8. It is very obvious to notice that the majority of mothers (82%) were practicing folic acid intake; meanwhile the rest (18%) did not take folic acid at all.

Influence of Awareness, Diet and Folic Acid

Table 8: Influences of age & education on anemia level on pregnant women

	Percentage of Women with Anemia					
Terms of influence	**Normal >11.0g/dl**	**Mild anemia 11.0 – 9 g/dl**	**Moderate Anemia 9.0 – 7.0 g/dl**	**Severe anemia 7.0 - 4.0 g/dl**	**Very severe anemia < 4.0 g/dl**	**Total no (n=100)**
Awareness						
Very aware	-	16	-	-	-	16
Aware	-	-	31	-	-	31
Aware to some Extent	-	-	-	29	21	50
Not aware	-	-	-	-	3	3
Diet						
Adequate	-	12	5	3	4	24
Poor	-	9	13	10	4	36
Very poor	-	-	-	-	-	40
Folic acid						
Intake	-	26	31	18	7	82
Not intake	-	-	-	-	18	18

The results shown in Table 9 revealed that awareness had a very significant effect on the presence of anaemia among pregnant women. In fact, it was not an astonishing matter to find that more than half of the interviewed women (about 18%) were not aware or had a little awareness about the danger of anaemia due to that fact that the majority of these women was either illiterate or had a primary or secondary education as described before.

The awareness of these facts responded by the interviewed women is shown in te previous table. It is obvious that the majority of mothers were either not aware (3%) or aware to some extent (50%) about the danger of anaemia. Table 7 shows that the prevalence of anaemia was higher among women who have intake of very poor diet. The ratio of women having very poor diet with presence of anaemia (in all levels altogether) was 90, 89.55 and 98.55 % for women having adequate, poor and very poor diet respectively. Actually, it was unusual to notice that even women having adequate diet were also suffering from anaemia which could be attributed to some other interacted factors.

As declared in Table 8, although the percentage of women taking folic acid during pregnancy stages was much higher than those who did not acquire it, there is no significant difference among women in their response to folic acid during all stages of pregnancy. This could be attributed to the little uptake of folic acid by the interviewed women.

Hemoglobin Level

Table 9: Ranges of Hemoglobin level in pregnant women

Hemoglobin level	Number (percentage)
11.0 – 9g/dl	(29%)
9.0 – 7.0 g/dl	(39%)
7.0 - 4.0 g/dl	(22%)
< 4.0 g/dl	(10%)

As shown in Table 10, about 22% (22 women) were suffering from severe and 10% were very severeanaemia. The problem of anaemia makes women feel cold, weak, dizzy and irritable during pregnancy. In addition, about 68% of the investigated

women sample was suffering from mild and moderate anaemia. In total, more than 95% of the examined women had anaemia during pregnancy leading to a negative influence on their ordinary life activities.

Child Spacing

Table 10: Child spacing in pregnant women

Child Spacing	Number (Percentage)
>2yrs	(63%)
<2yrs	(37%)

The collected data indicated about 63 % of mothers had more than two years between repetitive pregnancies and 37% of women had a child spacing of less than two years.

Discussion

Although the sample of mothers was not normally distributed in an ideal manner, the wide range of their ages gave a better change to study the influences of age on anaemia conditions related to eating habits, education and overall awareness. Most of the subjects are hindus as the area where the study conducted is Hindu dominant. The hospital, where the study is conducted is situated in urban area & this can be the reason of this prevalence. Indeed, these unoptimistic figures indicated that hindered features could be expected from the examined society as will be explained later in the association section between education and presence of anaemia. At the same time maternal education had a significant influence on nutritional status. The rate of moderate to very severe anaemia in wives of husbands who had postgraduate, university, secondary and primary educations were 13,18, 20 & 23% respectively indicating that when the education level of women's husband was high the anaemia level reduced considerably. women education has a great influence on their attitude of hemoglobin deficiency leading to anaemia disaster. In brief, anaemia decreases steadily with the increases in the level of educational attainment in the interviewed women. Low education level has indirect effects on the understanding of nutrition and food aspects as well as improvement of the socio-economic conditions. Family income was another important factor related to the anaemia level since it improves some other related factors such as nutrition, education, awareness and hygienic conditions. Diet and nutritional status of the pregnant women is another angle of the problem that has been dealt with in this study because it is well known that there are differentials in the anaemia rates by nutritional characteristics. The result probably can explain the very high percentages of anemic mothers in this study since it is extremely associated to the nutrition condition of the mothers.

The main aspect of care for persons affected by anaemia involves early treatment intervention of preventable health problems such as analgesics, antibiotics, vitamins; folic acid supplementation and high fluid intake are periodically used.

Having a healthy baby means that mothers must be healthy too. Folic acid, sometimes called folate, is a B vitamin (B9) found mostly in leafy green vegetables like kale and spinach, orange juice, and enriched grains. Mothersbodyneeds folate to make normal red blood cells and prevent anaemia. One of the most important things mothers can do to fulfil their body needs and to help prevent serious problems is to get enough folic acid every day- especially during early pregnancy. Folic acid is also essential for the formation and maturation of red blood cells and necessary for cell growth and repair. Deficiency of folate reduces the rate of DNA synthesis with consequent impaired cell proliferation and intramedullary death of resulting abnormal cells; this shortens the lifespan of circulating red blood cells and results in anaemia. There is, however, little evidence that folic acid deficiency may be a public health problem in many developing countries. Awareness in this context indicated to the state and the ability to perceive the danger of anaemia and its negative consequences during and after pregnancy. The only way to realize the dangers of anaemia would be throughout better awareness either during education or by increasing this knowledge by organized campaigns. Maternal education level therefore influences the food choices and feeding patterns of family members.

Majority of the women in this study had attained only primary level education. Marital status has been reported to influence pregnancy outcome. Generally speaking, awareness had an inverse effect on the presence of anaemia, when the awareness increased the existence of anaemia among women decreased significantly. As a matter of fact, the inadequate nutritional practices usually lead to anaemia particularly in pregnant women. On the other hand, adequate amounts of protein, fat, carbohydrates, vitamins, and minerals are required for a well-balanced diet.

Considering differentials by women's nutritional

status, the greatest variation in anaemia was observed when the diet was rather poor. When the diet enhanced the haemoglobin level in the interviewed women was improved very significantly.

In general, poverty has a negative effect on the consumption of nutritious types of food. Women in households with a low standard of living are less likely than other women to eat various foods, and their diet is particularly deficient in fundamental element. It was foreseen that women residing in urban areas should be less likely for substantial anaemia conditions than women residing in rural areas because they have access to every type of food in their diet, particularly nutritious foods, and access to more advanced public and private clinics. The dietary intake of rural pregnant women was lower than the recommended level. Because anemia usually results from a nutritional deficiency of iron, folate, vitamin B12, or some other nutrients, it is quite vital to look after of the women's diet especially during pregnancy. The consumption of a wide variety of nutritious foods is important for women's health. For example, green, leafy vegetables are a rich source of iron, folic acid, vitamin C, carotene, riboflavin, and calcium. It is reported that riboflavin deficiency may be quite common in developing countries where intake of animal products is low, and especially during seasons when there is less intake of vegetables. Vitamin B12 is necessary for the synthesis of red blood cells and its deficiencies have been associated with anaemia. Therefore, diets with little or no animal protein, as it is often the case in the developing world, coupled with malabsorption related to parasitic infections of the small intestine, might result in Vitamin B_{12} deficiency.

Usually, iron and folic acid tablets are provided to pregnant women in order to prevent anaemia during pregnancy. The provision of iron and folic acid supplements to pregnant women has undoubtedly reduced the overall prevalence of anaemia in pregnant women. However, the result tabulated in Table 8 revealed that intake of folic acid was insufficient for reducing the prevalence of anaemia in the interviewed women because both women who intake or did not intake folic acid are suffering from anaemia.This result could be elucidated to the low amount of folic acid taken by the women which was not enough to beat this epidemic dominant problem. Supplementation of iron during pregnancy is one of the main components of the anaemia control and prevention strategy. The provision of iron and folic acid supplements to pregnant women will undoubtedly reduce the overall prevalence of anaemia in pregnant women. Because folic acid is an essential element that usually used to alleviate the problem of anaemia, this strategic component was investigated in the current study.

Anaemia in pregnancy is defined by World Health Organization as hemoglobin level of less than 11.0 g/dl and often classified as: Mild degree (9.0-11.0g/dl), Moderate (7.0-9.0g/dl), Severer (7.0-4.0g/dl), Very Severe (<4.0g/dl). Based on this classification, the examined women samples were classified according to the measured hemoglobin in their blood analyses. Hemoglobin is the protein molecule in red blood cells that carries oxygen from the lungs to the body's tissues and returns carbon dioxide from the tissues to the lungs. Hemoglobin levels indicate the oxygen carrying capacity of the blood. Anaemia occurs when the blood does not have enough hemoglobin because the blood does not carry enough oxygen to the rest of the women's body. Therefore, anaemia is a medical condition in which the red blood cell count or hemoglobin is less than normal. The normal level of hemoglobin is generally different in males and females as well as in pregnant females. For women, anaemia is typically defined as hemoglobin level of less than certain thresholds.

Time interval between pregnancies strongly influences the outcome of the subsequent pregnancies. Short birth interval does not give the mother enough time to recuperate from the nutritional burden of the previous pregnancy, which may lead to poor pregnancy outcomes. This interesting distribution will be associated with anaemia in the subsequent part of this study. Good pregnancy outcomes are expected when there is a gap of at least 18 – 23 months between the consecutive pregnancies. Child spacing means the period between two consecutive pregnancies of the same mother. Because the nutritional burden on the mother between pregnancies depends on the extent of breastfeeding, the inter-pregnancy interval and the 'recuperative interval' (duration of the non-pregnant, non-lactating interval) could measure whether the mother has had a chance to recover from the pregnancy. Therefore, it is expected an increased risk for maternal anaemia when the inter-pregnancy interval is very short.

Conclusion

In this study, the prevalence of anaemia among pregnant women was investigated under the influence of some nutritional and socio-economic factors. The health services is available and accessible in general, but a major constraint is that the people could not afford to utilise it, because of the quality of

the service, delivered there is poor quality awareness of women about the health services. The prevalence was higher in poorly educated women, women with large family size, and those who do not use family planning services.

The study revealed that the prevalence of anaemia was the same among women who attend clinical units and using iron supplementation and women who do not attend or use iron supplementation. These findings strongly raise the issue of the awareness of mothers towards their health and family. More studies are needed to explore the causes of the failure to prevent anaemia among pregnant women. It is recommended to redistribute the health services according to needs of the population, to train clinical providers to deliver services up to the standard of the guidelines recommended by the World Health Organization, to increase the awareness of midwives regarding diagnosis, treatment and referral system of anaemia cases, to implement advocacy program to increase the utilization of family planning services, and iron supplementation in reproductive age and to revitalize the cooperation and coordination between school health and health education departments to raise the awareness of women in reproductive age, particularly girls in secondary schools for better anaemia prevention.

References

1. World Health Organization. WHO/NUT/MCM/92.2. WHO; Geneva: 1992. The prevalence of anemia in women: A tabulation of available information.
2. Centres for Disease Control and Prevention. Recommendations to Prevent and Control Iron Deficiency in the United States. Morbidity and Mortality Weekly Report. 1998;47(No. RR-3).
3. Breymann C, Bian X, Blanco-Capito LR, et al. Expert recommendations for the diagnosis and treatment of iron-deficiency anemia during pregnancy and the postpartum period in the Asia-Pacific region. Journal of Perinatal Medicine. 2010;38:1-8.
4. Milman N.Prepartum anaemia: prevention and treatment. Annals of Haematology. 2008;87:949-59.
5. Reveiz L, Gyte GMI, Cuervo LG. Treatments for iron-deficiency anaemia in pregnancy. The Cochrane Database of Systematic reviews. 2007;(2).
6. Johnson TA. Anaemia. In: Luesley DM, Baker PN, editors. Obstetrics and Gynaecology An evidence-based text for MRCOG. 2nd ed. London: Hodder Arnold; 2010.p.139-43.
7. Pavord S, Myers B, Robinson B, Allard S, Strong J, Oppenheimer C. UK guidelines on the management of iron deficiency in pregnancy. Br J Haematol. 2012;156(5):588-600.
8. South Australian Perinatal Practice Guidelines. Chapter 60 Anaemia in pregnancy. South Australia [Updated 2012 May 22; cited 2013 December 17].
9. UNICEF and Micronutrient Initiative. Vitamin and mineral deficiency: a global progress report March 2004.
10. World Health Organization. WHO/NUT/MCM/92.2. WHO; Geneva: 1992. The prevalence of anemia in women: A tabulation of available information.
11. Kennedy E. Dietary reference intakes:development and uses for assessment of micronutrient status of women–a global prospective Am J ClinNutr 2005;81(suppl):1194S-7S.
12. World Health Organisation.The prevalence of anemia in pregnancy, WHO Tehnical reports (1992-1993).
13. Centers for disease Control, Criteria for anemia in children and childbearing aged women. MMWR 1989;38:400-4.
14. Sharma J.B. Nutritional anemia during pregnancy in non-industrial countries, Progress in Obst.&Gynae (Studd)2003;5:103-122.
15. Ross AC,Gardner EM.The function of vitamin A in cellular growth and differentiation and its role during pregnancy and lactation. AdvExp Med Biol 1994;352:187-200.
16. Milman N, Bergholt T,BygK.E,EriksonL,GradualN. Iron status and balance during pregnancy .A critical reappraisal of iron supplementation .ActaObstet GynaecolScand 1999;78:749-57.
17. Hallberg L , Bjorn-Rassmussen E. Determination of Iron absorbtion from whole diet .A new tool model using two radiation isotopes given as heam and non heam iron. Sc and J Haematol 1972;9:193-197.
18. Sharma JB, Soni D, Murthy NS, Malhotra M.J. Effect of dietary habits on prevalence of anemia in pregnant women of Delhi. ObstetGynaecol Res. 2003 [PubMed - indexed for MEDLINE].
19. Sharma J.B. Nutritional anemia during pregnancy in non industrial countries, Progress in Obst. & Gynae (Studd) 2003;15:103-122.
20. Sharma JB, Arora BS , Kumar S Goel S, Dhamija A. Helminth and protozoal intestinal infection;an important cause for anemia in pregnant women in Delhi, India, J ObstetGynecolInd 200:51(6):58-61.
21. Abel R, Rajaratnam J, Sampathkumar V. Anemia in pregnancy. Impact of iron, Deworming and IEC, RUSH Dept.Tamil Nadu CMC Vellor, 1999.
22. Bhatt. RV. Poor iron compliance –the way out. J ObstetGynecol Ind 1997;47:185-190..
23. Madhavan Nair, K Brahaman. Impact evalution of Iron and Iodine Fortified salts. Indian J Med Res 1998; 108:203.

24. Dietary Reference Intakes in Japan-2005. Tokyo: Dai-Ichi Shuppan Publishing. Co. Ltd.; 2005. (in Japanese).
25. US Preventive Services Task Force. Routine iron supplementation during pregnancy. Review article. JAMA. 1993;270:2848–2854.
26. Mahomed K. WITHDRAWN: Iron supplementation in pregnancy. Cochrane Database Syst Rev. 2007;18 (3):CD000117.
27. Scholl TO. Iron status during pregnancy: setting the stage for mother and infant. Am J ClinNutr. 2005; 81:1218S–1222S.
28. Notice from the Children and Families Bureau, Ministry of Health and Welfare "Promotion of the provision of appropriate information about folic acid intake in women of childbearing age to reduce the risk of developing impairment of neural tube closure" 2000 Dec 28;72:78.
29. Sibai BM. The HELLP syndrome (hemolysis, elevated liver enzymes, and low platelets): much ado about nothing? Am J Obstet Gynecol. 1990;162:311–316.
30. Pasricha SRS, Flecknoe-Brown SC, Allen KJ, et al. Diagnosis and management of iron deficiency anaemia: a clinical update. MJA. 2010;193(9):525-32.
31. Milman N. Iron and pregnancy - a delicate balance. Annals of Hematology. 2006;85:559-65.
32. The American College of Obstetricians and Gynecologists. ACOG Practice Bulletin No. 95 Anemia in Pregnancy. Obstetrics &Gynecology. 2008;112(1):201-7.
33. Reveiz L, Gyte GMI, Cuervo LG. Treatments for iron-deficiency anaemia in pregnancy. The Cochrane Database of Systematic reviews. 2007(2).
34. Sharma JB.Medical complications in pregnancy. In: Sharma JB. (ed). The Obstetric Protocol, 1st ed. Delhi; jaypee Brothers, 1998;78-98.
35. Letsky E. Blood volume, haematinics, anemeia. In de Swiet M. (ed) Medical Disorders in Obstetric Practice, 3rd end. Oxford: Blackwell, 1995;33-60.
36. Lewis BJ, Laras RK. Leukemia and lymphoma in pregnancy i.in Lavos RK (ed) Blood disorder in pregnancy.Lea and Febriger: Philaelphia 1986:85 -101.
37. Johnson TA. Anaemia. In: Luesley DM, Baker PN, editors. Obstetrics and Gynaecology An evidence-based text for MRCOG. 2nd ed. London: Hodder Arnold; 2010.p.139-43.
38. Lloyd C.Medical disorders associated with pregnancy. In: Fraser DM, Cooper MA, editors. Myles Textbook for Midwives. 15th ed. London: Churchill Livingstone; 2009.p.361-96.
39. Killip S, Bennett JM, Chambers MD. Iron Deficiency Anemia. American Family Physician. 2007;75:671-8.
40. The Royal Australian College of General Practitioners, Australasian Society of Clinical and Experimental Pharmacologists and Toxicologists, Pharmaceutical Society of Australia. Australian Medicines Handbook 51. Adelaide 2008.
41. Mosby's Medical Dictionary, 8th edition. © 2009, Elsevier.
42. Segen's Medical Dictionary. © 2012 Farlex.
43. Medical Dictionary, © 2009 Farlex and Partners.
44. National Center for Educational Statistics. 31 March 2008.
45. Marmot, Michael. The Status Syndrome: How Social Standing Affects Our Health and Longevity. New York: Owl Books. 2004.
46. Werner, Shirli, Malaspina, Dolores, and Rabinowitz, Jonathan. Socioeconomic Status at Birth is associated with Risk of Schizophrenia: Population-Based Multilevel Study. Schizophrenia Bulletin. 18 April 2007.
47. Hunt, J. Early Education and Social Class. (1972, October 4).
48. Erica Goode. 13 April. "For Good Health, it helps to be Rich and Important." New York Times.
49. Werner, Shirli, Malaspina, Dolores, and Rabinowitz, Jonathan. Socioeconomic Status at Birth is associated with Risk of Schizophrenia: Population-Based Multilevel Study. Schizophrenia Bulletin. 18 April 2007.
50. American Psychological Association, Task Force on Socioeconomic Status. Report of the APA Task Force on Socioeconomic Status. Washington, D.C.: American Psychological Association, 2007.
51. Lareau, Annette. Unequal Childhoods: Race, Class, and Family Life. University of California Pres. 2003.
52. Gollnick, Chinn. Multicultural Education in a Pluralistic Society. 2013.
53. American Psychological Association (2012). ''Education & Socioeconomic Status. Retrieved from Gollnick, Chinn. (2013). Multicultural Education in a Pluralistic Society.
54. Stanek. Talking About Class. 2012.
55. Milne A &Plourde, L. A. Factors of a Low-SES Household: What Aids Academic Achievement? 2006.
56. Markus, H.; Conner, A. Clash!: 8 cultural conflicts that make us who we are. New York, NY: Hudson Street Press. 2013.p.89–112.
57. Farrant, Brad; Stephen Zubrick. "Early vocabulary development: The importance of joint attention and parent-child book reading". First Language: 2012;343–364.
58. World Health Organization. WHO global database on iron deficiency anaemia & micronutrients, Geneva; WHO Publication. 2001.
59. Boushey, Heather and Weller, Christian. Inequality Matters: The Growing Economic Divide in America and its Poisonous Consequences."What the Numbers Tell Us." 2005.p.27-40.

Subscription Information
Institutional (1 year) INR5000/USD357

Here is payment instruction for your reference.

Check:
Please send the US dollar check from outside India and INR check from India made:
Payable to 'Red Flower Publication Private Limited'.
Drawn on Delhi branch

PayPal Instructions for the payment (only for transfer from outside India):
Payments can be made through our PayPal account at https://www.paypal.com.
Our PayPal recipient email address is redflowerppl@gmail.com.

Credit Card:
We accept Visa or MasterCard.

Wire transfer:
Complete Bank Account No. 604320110000467
Beneficiary Name: Red Flower Publication Pvt. Ltd.
Bank & Branch Name: Bank of India; Mayur Vihar
MICR Code: 110013045
Branch Code: 6043
IFSC Code: BKID0006043 (used for RTGS and NEFT transactions)
Swift Code: BKIDINBBDOS

**Please kindly add bank charge at your side if you pay by check or wire transfer.

Payment, orders and all correspondences should be sent to;
Red Flower Publication Pvt. Ltd.
48/41-42, DSIDC, Pocket-II
Mayur Vihar Phase-I
Delhi - 110 091(India)

Original Article

International Journal of Food, Nutrition and Dietetics
Volume 5 Number 2, May - August 2017
DOI: http://dx.doi.org/10.21088/ijfnd.2322.0775.5217.2

Organoleptic Properties of a Standardised Food Product (Cookies) Developed from Beet Root Extract and Bengal Gram Flour

Luxita Sharma*, Mansi Sardana**

Abstract

Food product development is the need of society today. The food products are available in the market but lack nutritional quality. Therefore in present study there is a need of society and industry to produce new food products. We have developed beet root cookies with the combination of Bengal gram flour , beet root and sesame seeds. We have taken different ratios of the main ingredients and cookies were developed by incorporating the beetroot extract and Bengal gram flour in four in the ratio i.e. 50:50, 60:40, 70:30 and 80:20. The beet root was grinded and the extract was taken out with sieving and pressing. Then in the Bengal gram, Maida, sesame seeds, Butter , Sugar and the extraxt was mixed to prepare the cookies. A panel of Ten experts from field of Nutrition were selected to mark the food samples in different ratios. Four samples were made and Sample B scored highest on hedonic scale of sensory evaluation. This resulted that Sample B was acceptable in terms of Color, Taste, Texture , After taste and Overall aceeptability.

Keywords: Beet Root; Extract; Bengal Gram; Food Product; Cookies.

Introduction

Beetroot is the hardy and cool season vegetable crop which is grown throughout the world . It has been classified as B. vulgaris and belongs to genus Beta and family Chenopodiaceae and is usually known by several names like beet, sea beet, chard , garden beet, chukander (in hindi). It is basically the taproot portion of beet plant [1]. The earliest form of beetroot is the wild sea beet and is the source for all different beetroot varieties available today. Beetroot requires an ideal temperature of about 18 to 25 Degree Celsius and does not grow well in extreme hot and extreme cold weathers. It grows well in deep and well drained, loose, loamy to sandy soils that is free from large stones. The best suitable pH that is required for beetroot cultivation is 6.0 to 7.0. Acidic soils should be avoided. Cultivation of beetroot requires a lot of water and frequent irrigation in drought and summer season so it is better to sow this crop on arrival of monsoons.

A one cup serving of boiled beets contain 74 calories, very low fat i.e. 0.15g and 2g of fibre. It also meet the 17% of vitamins daily intake based on 2,000 calorie intake and 14% of mineral daily intake. Beetroot is having glycaemic index of score 61 and glycaemic load is only 5 which means that it does not have major effect on blood sugar level. Due to antioxidant, antiapoptosis and anti-inflammatory properties, beetroot has a renal protective potential [2]. In ancient times, beetroot was believed to enhance human sex hormones and as an aphrodisiac and the juice of beetroot was also consumed to expel kidney and bladder stones [3]. It is a natural food that can be used to boost the energy in athletes. The latest study suggest that beetroot juice shows its performance at peak at 2-3 hours after ingestion. The requirement of the oxygen to maintain a level of moderate exercise after consuming beetroot juice decreases in amount . The best results show the declining level of oxygen consumption by about three percent. Researchers also found that the acute ingestion of 2 bottles of beetroot juice concentrate will show maximal effect on exercise capacity [4] and 6 days of beetroot juice supplementation has shown a significant improvement in 10-km cycle TT performance [5].

Beetroots are high in betaine, a nutrient that helps

Author's Affiliation: *Assistant Professor-II & Head **Student, Department of Dietetics and Applied Nutrition, Amity Medical School, Amity University, Gurgaon.

Corresponding Author: Sharma Luxita, Assistant Professor & Head, G-105 , Surya Vihar, Near Kapashera Border, Gurgaon-110037, Haryana, India.
E-mail: lakshita1982@gmail.com, lshrama@ggn.amity.edu

Recieved on 26.02.2017, **Accepted on** 04.03.2017

protect cells, proteins and enzymes from environmental stress and also help to fight inflammation , protect internal organs, which is used to lower toxic levels of Homocysteine (Hcy) (this contributes to development of heart disease, stroke and peripheral vascular disease) so it is a potential herb used in cardiovascular disease [6]. Moreover Beta vulgairs var. rubra has shown tumor inhibitory effects in skin and lung cancer [7]. Recent research shows that beetroot provides a high number of antioxidants. Moreover it is a significant source of dietary polyphenols [8]. It can also improve the clinical outcomes of Type 2 Diabetes. Many studies proved that beetroot also contribute to improve the haemoglobin level in blood. Hence a study was conducted by to evaluate the effectiveness of beetroot juice on haemoglobin level among adolescent girls. This study concludes that the all adolescent girls who are anaemic can take the beetroot juice for 20 days to improve their haemoglobin level [9]. It has been also claimed that beets helps in building red corpuscles and add tones to blood so that haemoglobin level increases.

The nitrate supplementation provided by beetroot juice improves exercise tolerance through vascular control and elevated oxygen delivery to skeletal muscles [4]. Furthermore beetroot juice was found to have blood pressure lowering and vaso protective effects [10]. A daily intake of one glass of beetroot juice can lower blood pressure in people with hypertension. In general, dietary intake of nitrate or nitrite has proved beneficial to NO-mediated physiological effects in humans, such as regulation of blood pressure, vascular control and enhanced vasodilation [11,12]. A new study by researchers at Wake Forest University has shown that daily consumption of beetroot juice can foster brain health in older adults .Consumption of beetroot leaves are beneficial for faster healing of wounds [13].

Gram flour is known as garbanzo bean flour or besan and it is a white pulse flour made from ground chickpeas or channa dal. It is also known as gram in some of the Asian countries and kaalachanna in both Hindi and Urdu or chhola boot. It is a staple ingredient in Indian, Pakistani, Nepali and Bangladeshi cuisines. It can be made from either raw or roasted gram beans. It is believed to be one of the oldest pulses known and cultivated in Asia and Europe. According to Aykoid and Doughty (1964), the eastern Mediterranean is stated as the centre of origin of Bengal gram, but its probable place of origin lies in Southwestern Asia i.e. countries like Afganistan and Persia. According to De Candolle, Sanskrit name "Chanaka" of Bengal gram flour indicates that the crop was under cultivation in India longer than in any country in the world.

Besan flour contains 387 calories per cup. It also has 11 grams of sugar, 22 grams of protein, 7 grams of fat, 11 grams of fiber and 58 g of carbohydrates. 75% of lipid content present in besan is unsaturated fatty acids in which linoleic acid comprises 43% of total fat. One third of the starch present in besan is Amylose, which is a slowly digested starch that helps to feel full longer. It is a protein rich supplement to cereal based diets, especially to poor in developing countries, where people cannot consume or afford animal protein or are vegetarians. The pulse proteins contain high amount of lysine and have low sulphur containing amino acids. Gram seeds contain high percentage of oil (4-5%) than other pulses. The glycaemic index of Bengal gram flour is just 10 which is low so it is a great food for diabetes. Blended Bengal gram flour can be used with wheat flour to make "basini roti" which is mainly unleavened bread commonly consumed by diabetic patient. Neutral detergent fiber present in Bengal gram flour can also lower glucose level in body so it can be used for control of diabetes [14]. Being rich in iron, consumption ofbesan on daily basis can help the body to recover from iron deficiency like anaemia. A study also stated that regular consumption of pulses performs a protective effect on risk for cardiovascular diseases. Pulses also contain a rich variety of compounds, which if consumed in sufficient amount may help to reduce tumour risk. Bengal gram flour contains molybdenum which is a mineral that is used to detoxify sulphites (a preservative found in wine, meat and salad in salad bars) [15]. It provides dietary calcium as about the same as yogurt and close to milk. It also possesses hypolipidemic action. It has been suggested that natural carbohydrates, especially rich in dietary fiber may protect against atherosclerosis and may reduce hypercholesterolemia so Bengal gram flour can be used to prevent these diseases. Several studies also reveal that fiber rich diet i.e. diet containing Bengal gram flour can minimise the toxic effects of pesticides [14]. Exiting antioxidant properties of raw and cooked chickpeas is due to presence of carotenoids [16], total polyphenol and tannins [17]. So inclusion of Bengal gram in daily diet will afford protection against many of the disorders.

Sesame seeds are known to be as the oldest condiments. They are tiny, flat oval seeds with a nutty taste. Sesame (Sesamumindicum L.) belongs to the Pedaliaceae family and also known by several names like benniseed, gingelly, simsim, til etc. It was a major oilseed crop in the ancient world due to its easiness,

great stability and resistance to drought. India, China and Mexico are the largest commercial producers of sesame seeds. They are given more importance just because of their oil which is resistant to rancidity.

Sesame seeds grow best in well-drained soil with a medium texture and neutral pH. They require 90 to 120 frost free days and temperature above 23 degree Celsius. Moreover these crops are drought tolerant due to extensive root system.

Sesame seeds have the highest oil content as compared to rapeseed, peanut, soybean and other oil crops, it is rich in oil (50-60%), protein (18-25%), carbohydrate and ash. Oils of sesame seeds are used as raw material in the manufacture of linoleic acid which is a therapeutic nutrient with antioxidant and anti-tumor therapeutic properties. Moreover monounsaturated fatty acids present in seeds helps in removing dangerous LDL cholesterol from arteries and blood vessels, thereby preventing against atherosclerosis, heart attack and strokes. The impressive levels of essential minerals like zinc, calcium and phosphorus helps to maintain body's bone health and prevent osteoporosis. Moreover phosphorus is also required for kidney function, cell maintanence and maintaining body's acid-alkaline balance so sesame seeds also serves this function in the body. They have also been found to have immunoglobulin E [18]. They also contain the lignans, sesamolin, sesamin, pinoresinol and lariciresinol [19] [20]. Organic compound sesamol in sesame seeds have been associated in protecting DNA against the harmful effects of radiation. Magnesium present in these seeds have shown protective effect against asthma and other respiratory disorders by preventing airway spasms. Black seeds increase the liver blood therefore beneficial for liver and also for nourishing the eyes.sesameseds contain phytate which is a cancer preventing compound and reduces the impact and effect of free radicals.it is also known to cure bleeding dysentery, burns ear pain , headache and impotency.

Maida is known as white wheat flour without any bran in south india and it is basically finely milled refined and bleached white flour. It is made from the endosperm of the grain. The limiting use of maida in preparation of leavened breads is just because of the denaturation of protein by the heat generated during milling process.

Materials and Method

Procurement of Raw Material

Beetroot were purchased online from Big Basket Store. The raw materials were physically examined to ensure they were disease free and stored in a cool temperature. Bengal gram flour, Maida and salt were purchased from local market, Panipat, Haryana, India. Sesame seeds, vanilla essence, Baking powder, butter were purchased from Departmental store in Amity university, Manesar, Haryana, India. Castor sugar was obtained from Spar, MGF Mall, Gurgaon. Sesame seeds were milled in a grinder to obtain sesame powder and Beetroot was milled to obtain Beetroot extract. All the ingredients are carried to Nutritional lab of Dietetics and Applied Nutrition, Amity university, Haryana.

Standardisation of Food Product

The recipe for cookies was standardised using the following

S. No.	Ingredients	Quantity (in grams)
1.	Maida	170g
2.	Sesame seeds	63g
3.	Baking powder	2g
4.	Salt	0.2g
5.	Vanilla essence	2g
6.	Castor sugar	100g
7.	Beet root	125 -200g
8.	Bengal gram flour	50-125g

After the standardisation of the ingredients, the ingredients are being proceed for development.

Baking requires the dough to be gentle. The magic of baking comes in full taste when the dough is the appropriate one. The type of dough and flour affects the structure and texture of the cookies. Handling of dough requires much techniques like more of whisking .The contents of the dough (Maida, Bengal gram flour etc) should be measured with precision.. As we are using Bengal gram flour which is a high protein flour thus it absorbs more moisture making the dough a drier and tougher one. Thus to make coookies soft some amount of maida is also added in the dough.The kneading of the dough should be proper so that no lumps are formed and the dough is a smooth one. The apt dough for the cookies is the one that is little harder than the normal dough we use to make chapatis. It should be supple and when broken into pieces less incisions should be visible.

Development of Food Products (Cookies)

Using the above standardised recipe, cookies were developed by incorporating the beetroot extract and Bengal gram flour in four ratio i.e. 50:50, 60:40, 70:30, 80:20. The method used in developing these cookies

are as follows.

First of all, Beetroot was peeled and cut into small pieces. These small pieces of beetroot undergoes grinding in grinding machine until a thin form of beetroot extract was obtained. Then Beetroot extract was collected in a bowl. Sesame seeds were roasted in frying pan over gas fuel and then kept for few minutes so that their temperature comes to room temperature. Then these sesame seeds are grinded until they take a form of powder and collected in a bowl.

Then four bowl of same size were collected to make four variations and marked as A, B, C, D. Ingredients including 170g of Maida, 4g of vanilla essence, 2g of baking powder, 100g of castor sugar and a pinch of salt were added into all four bowl to form dough of cookies. The appropriate amount of beetroot extract and Bengal gram flour was weighed using an electronic balance to give the various ratios of this mixture.

Beetroot and Bengal gram flour were added to all four bowl according to their quantities in different variation. To make the variation A, 50% of beetroot (125g) and 50% of Bengal gram flour (125) were added to bowl marked as A. To make variation B, 60% of beetroot (150g) and 40% of Bengal gram flour (100g) were added to bowl marked as B. To make variation C, 70% of beetroot (175g) and 30% of Bengal gram flour (75g) was added to bowl marked as C. To make variation D, 80% of beetroot (200g) and 20% of Bengal gram flour (50g) was added to bowl marked as D. Butter was melted in pan over gas and poured over the mixtures in all four bowl. All the ingredients added in different bowl undergoes mixing separately to form a suitable dough. The dough of all four varieties was left for 10 minutes to achieve better results.

The dough of variety A was shaped into rectangle, dough of variety B was shaped into circle, dough of variety C was shaped into triangle, dough of variety C was shaped into square. OTG is pre-heated at 180 degree Celsius for 10 minutes and OTG tray was greased with butter to avoid sticking of dough to tray. Then these shaped dough were kept into tray for baking turn by turn with variety A undergoing baking at first then followed by variety B, then by variety C and then by variety D. All the variations undergo baking at temperature of 170C-180C for 20 minutes. After the cookies were baked, all the cookies were kept in different containers marked as A, B, C, D.

Sensory Evaluation of Food Product

Then sensory evaluation of four samples were being done at 9 point hedonic scale. For each variation , 20 hedonic tests were conducted by 20 different panellists /experts from the field of Nutrition. Hedonic tests were done on the basis of

- Taste
- Colour
- Texture
- Firmness
- Crispiness
- Overall

Each individual gave his rating on the basis of his likes or dislikes. After conducting the sensory evaluation, statistical analysis was done. This was done on the basis of Mean and Standard deviation of all attributes. In statistical analysis we jot down all the points given by the individual in different attributes.

Result and Discussion

After the sensory evaluation the product were statistically analysed using Mean and Standard deviation. According to above information, we got to know that following samples have following attributes.

Sample A

Taste: The sample had mean 8.85± 0.85 scores depicting the taste factor. It was felt by the experts that both the ingredients i.e. beetroot and Bengal gram flour tasted equally.

Colour: The sample hadmean 9.1± 0.83 scores in this aspect and it's colour was quite similar to red as beetroot content was highest in it. As colour factor is very important because the food is at first seen by the eyes so the Sample A had an attractive red colour.

Texture: The sample had mean 8.6 ± 1.24 scores in texture and it was observed as crumbly and thin in texture and had a smooth top so it resembles the texture required for cookies.

Firmness: The sample had mean 8.5 ± 1.24 scores depicting the firmness factor and firmness was not ideal as it was supposed to be because it was quite difficult to break and chew.

Crispiness: The sample had mean 8.8 ± 0.87 scores in crispiness and it had a crisp taste and rated as second in this aspect.

Overall: Overall this sample was accepted by the

panellists upto much of the extent as all the ideal factors required for cookieswas not met and had 8.9±1.26 mean scores.

Sample B.

Taste: The sample had same mean scores as that of A i.e. 8.85±1.27 as it was also felt to have taste of both the ingredients equally .

Colour: The sample hadsimilar mean scores to that of A i.e. 9.15 ±1.01 but not exactly same as A and it possessed light red colour which was more appealing than sample A and more suited to the texture of this sample.

Texture: This sample had highest mean scores among all the samples i.e.9.1±0.88 and it was observed by experts as quite puffy with a fine and smooth top so it was considered as ideal sample among all.

Firmness: This sample was rated bestin this aspect among all and it had 9.05±0.92 mean scoresand it's firmness was similar to that required by the cookies i.e. neither too hard nor too soft and chewy also.

Crispiness: The sample had 9±2.35 mean scores in this aspect and it was crisp enough around the edges which adds on to the more appealing quality of this sample and can be easily crumbled.

Overall: Overall this sample was most accepted by panellists as it was rated best in all the attributes and had 9.5±1.14 mean scores.

Sample C

Taste: The sample had 8.35±0.79 mean scores in taste and it was observed after tasting that this sample had a bitter after taste so it did not satisfy the taste buds as compared to other samples.

Colour: This sample had 8.25± 0.82 mean scores depicting the taste factor and it was light red along with black finish. Vision stimulates taste thus the colour was not so eye relishing.

Texture: The sample had 8.55±0.92 mean scores in texture .It was found to have high flakiness and lack of puffiness thus the sample was not considered. It was thin, coarse and rough in texture.

Firmness: The sample had8.45±0.80 mean scores in firmness. Hard foods are not easily accepted and the sample was quite hard to break thus not accepted.

Crispiness: The sample had 8.5±0.80 mean scores in this aspect . The high crispiness made this sample hard to chew.

Overall: Overall this sample was accepted by onlysome of the panellists and it had 8.25±0.82 mean scores. Due to this sample lacking in all the considered aspects this sample was ranked on the third place.

Sample D

Taste: This sample was worst in taste due to high beetroot content which gave this sample a bitter taste.It had least 8.1±1.04 mean scores in this aspect as it was not liked.

Colour: This sample had 8.2±1.07 mean scores in colour and it was dark in colour i.e. a mixture of black and light reddue to the black colour this sample was not eye catching.

Texture: This sample had least mean scores among all the samples i.e. 8.15 ±1.10. It's texture was thin and craggy. Due to hard texture it became more tasteless .

Firmness: This sample had firmness above average so it was too hard to break and not easily chewable. It had least mean scores in terms of firmness i.e. 8.1±0.94.

Crispiness: This sample was too much crispy to chew and the crust was burnt which was not at all tasty so it had least mean scores i.e. 8.3±1.1 in this aspect.And was ranked at the last.

Overall: Overall this sample was not at all liked by the people as it has worst ratings in all of the attributes so it had 7.9±0.99 mean scores. The panellists rejected this sample mainly due to its exceeding firmness after taste .

It is clearly seen that sample containing 60% Beetroot (150g) and 40% Bengal gram flour (100g) is rated best followed by sample containing 50% beetroot (125g) and 50% Bengal gram flour (125g) , which is followed by sample containing 70% beetroot (175g) and 30% Bengal gram flour(75g) while the sample containing 80% beetroot (200g) and 20% Bengal gram flour (50g) is least rated.

All these results are calculated on the basis of standard deviation and mean of the samples. The cookies prepared from 80% beetroot (200g) and 20% Bengal gram flour (50g) i.e. sample D was very difficult to break as their firmness was above average. Moreover their texture was not too much appealing and they also taste bitter. Sample A i.e. 50% of beetroot (125g) and 50%of Bengal gram flour(125g) is not found as much as significant like B on other attributes like texture, colour, firmness. The reviews of patents also revealed that sample C i.e. 70% of beetroot 9175g) and 30% of Bengal gram flour(75g) was over baked. The storage capacity of these cookieswereobserved it

was found that these cookies can stay upto 6 – 7 days without addition of preservatives.

The result thus indicates that the panellist accepted the cookies prepared from 60% beetroot(150g) and 40% of Bengal gram flour (100g) at the most.

Chemical Composition of Cookies

Chemical composition of accepted cookies having 60% beetroot (150g) and 40% Bengal gram flour (100g) are summarized in Table 2. With the increase in beetroot content there is decrease in protein content.

Conclusion

After the evaluation of chemical composition, vitamin and mineral analysis of sample B i.e. 60% beetroot(150g) and 40% Bengal gram flour (100g), It has been concluded that sample B is rich in protein and iron. Moreover sample B results best in all the attributes as compared to other. It is also found that there is no difference in cooking time with change in amount of beetroot and Bengal gram flour. The results of this study are good indicators of the possibilities of better utilisation of beetroot and Bengal gram flour through developing variety of new food products. Around 5 cookies of sample B will almost meet the requirement of protein and iron. Though these cookies are iron rich it can be a good option for people who are suffering from anaemia.

References

1. "Beet". def. 1 and 2.also "beet-root". Oxford English Dictionary Second Edition on CD-ROM (v. 4.0) © Oxford University Press 2009.
2. Ali A. El Gamal, Mansour S. AlSaid, Mohammad Raish, Mohammed Al-Sohaibani, ShazaM. Al-Massarani, Ajaz Ahmad, MohamedHefnawy, Mohammed Al-Yahya, Omer A. Basoudan, and Syed Rafatullah .Beetroot (Beta vulgaris L.) Extract Ameliorates Gentamicin-Induced Nephrotoxicity Associated Oxidative Stress,Inflammation, and Apoptosis in Rodent Model.Mediat. Inflamm.2014, 2014.p.983–952.
3. N. Sharma, B. Tanwer, and Vijayvergia, "Study of medicinal plants in Aravali. Region of rajasthan for treatment of kidney stone and urinary track troubles", International journal of pharm Tech Research, 2011;3(1):110-113.
4. Wylie et al., L.J. Wylie, J. Kelly, S.J. Bailey, J.R. Blackwell, P.F. Skiba, P.G. Winyard, A.E. Jeukendrup, A. Vanhatalo, A.M. Jones Beetroot juice and exercise: pharmacodynamic and dose–response relationshipsJournal of Applied Physiology (1985), 2013; 115(3):325–336.
5. Cermak, N.M., Gibala, M.J., and van Loon, L.J. Nitrate supplementation's improvement of 10-km time-trial performance in trained cyclists. Int. J. Sport Nutr.Exerc.Metab. 20121;22(1):64–71.
6. L.Vali, E.Stefanovits-Banyai, k.Szentmihalyi, H.Febel, E.Sardi, Lugasi, A. kocsis, A.Blazorics, "Liver-protecting effects of table beet (Beta vulgaris varRubra) during ischemia – reperfusion, "Nutrition 2007;23:172-178.
7. Kapadia, G.J., Tokuda, H., Konoshima, T., Nishino, H., "Chemoprevention of lung and skin cancer by Beta vulgaris (beet) root extract,"Cancer Letters, 1996;100:211–214.
8. Peter C. Wootton-Beard, Lisa Ryan . A beetroot juice shot is a significant and convenient source of bioaccessible antioxidants Journal of Functional Foods 2011;3:329-334.
9. Dr. N. Gayathri Priya, Mrs. M. Malarvizhi, Mrs.AnnalJegaJothi . Beet root juice on haemoglobin among adolescent girls. IOSR Journal of Nursing and Health Science (IOSR-JNHS) e-ISSN: 2320–1959.p-ISSN: 2320–1940, 2013 Sep-Oct;2(1).
10. V. Kapil, A.B. Milsom, M. Okorie, S. Maleki-Toyserkani, F. Akram, F. Rehman, S. Arghandawi, V. Pearl, N. Benjamin, S. Loukogeorgakis, R. Macallister, A.J. Hobbs, A.J. Webb, A. Ahluwalia Inorganic nitrate supplementation lowers blood pressure in humans: role for nitrite-derived NO Hypertension, 2010;56(2):274–28.
11. Dejam, C.J. Hunter, M.T. GladwinEffects of dietary nitrate on blood pressureThe New England Journal of Medicine, 2007;356(15):1590.
12. Maher et al., 2008A.R. Maher, A.B. Milsom,P. Gunaruwan, K. Abozguia, I. Ahmed, R.A. Weaver, Thomas, H. Ashrafian, G.V. Born, P.E. James, M.P. FrenneauxHypoxic modulation of exogenous nitrite-induced vasodilation in human Circulation, 2008;117(5):670–677.
13. A.Singh, V.K. Garg, P.k. Sharma, and S.Gupta, "Wound healing activity of ethanolic extract of beta vulgaris," pharmacologyonline, 2011;1:1031-1038.
14. Indira M and Kurup PA, Effect of black gram fiber on toxic effects of organophosphorus insecticides, Indian J ExpBiol, 1980;18:1529.1
15. Murray MND. Health benefits benefits of Bengal gram flour. THeEncyclopedia of Healing Foods. New York: Atria Books. 2005.
16. Stahl, W. And Sies, H. Antioxidant activity of carotenoids.Molecular aspect of medicine 2003;(24)6: 345-351.
17. Scalbert, A., Monach, C. ,Morand, C., Jimenz, L. Dietary polyphenols and the prevention of diseases. Critical reviews in food science and nutrition

2005;(45)4: 287-306.

18. Agne, P.S.E., Rance, F. and Bidat, E. Sesame Seed Allergy. Rev. Franc. Allergol.Immunol.Clin. , 2003;43:507-516. [Shows sesame to contain immunoglo-bulin E (IgE)-mediated food allergens and highlights what could be the cause].
19. Milder, Ivon E.J.; Arts, Ilja C.W.; Betty; Venema, Dini P.; Hollman, Peter C.H. "Lignan contents of Dutch plant foods: a database including lariciresinol, pinoresinol, secoisolariciresinol and matairesinol". British Journal of Nutrition. 2005;93:393–402.
20. Kuo PC, Lin MC, Chen GF, Yiu TJ, Teen JT. "Identification of methanol-soluble compounds in sesame and evaluation of antioxidant potential of its lignans". J Agric Food Chem. 2011;59(7):3214–9.
21. C.gopalan,B. V. Rama Sastri and S. C. Balasubramanian. Nutritive value of Indian Foods.National Institue of NutritionIndian Council of Medical Research (ICMR) Hyderabad.

International Journal of Food, Nutrition & Dietetics

Library Recommendation Form

If you would like to recommend this journal to your library, simply complete the form below and return it to us. Please type or print the information clearly. We will forward a sample copy to your library, along with this recommendation card.

Please send a sample copy to:

Name of Librarian

Name of Library

Address of Library

Recommended by:

Your Name/ Title

Department

Address

Dear Librarian,

I would like to recommend that your library subscribe to the **International Journal of Food, Nutrition & Dietetics**. I believe the major future uses of the journal for your library would provide:

1. useful information for members of my specialty.
2. an excellent research aid.
3. an invaluable student resource.

I have a personal subscription and understand and appreciate the value an institutional subscription would mean to our staff.

Should the journal you're reading right now be a part of your University or institution's library? To have a free sample sent to your librarian, simply fill out and mail this today!

Stock Manager

Red Flower Publication Pvt. Ltd.

48/41-42, DSIDC, Pocket-II

Mayur Vihar Phase-I

Delhi - 110 091(India)

Phone: Phone: 91-11-45796900, 22754205, 22756995, Fax: 91-11-22754205

E-mail: sales@rfppl.co.in

Original Article

International Journal of Food, Nutrition and Dietetics
Volume 5 Number 2, May - August 2017
DOI: http://dx.doi.org/10.21088/ijfnd.2322.0775.5217.3

Status of Education and Training among Food Handlers from Selected Catering Establishments

Mamatha Mishra*, Jamuna Prakash**

Abstract

Food handler's training is an important key to food safety management system. To understand the requirements of training of food handlers, the study was conducted in the city of Bengaluru and the education level and awareness regarding food safety was captured. A total of 16 Food Business operators (FBO's) with 284 food handlers (FH) were selected. Two questionnaires were used for collecting information on the department of work, their literacy level and food safety trainings undergone. The result showed that the majority, 50% of the food handlers were in the department of chef and washing & cleaning, followed by the rest of the department consisting of manager, cashier, storekeeper, helper and service. The subjects comprised of 83% literate and 17% illiterate population. Most of the FH were middle school educated followed by secondary, senior secondary, primary and graduates. The cashiers and mangers were 100% educated and on the other side the washing and cleaning staff had more than 50 percent illiterate members. The rest of the team had a mix of education levels but more than 50% were literates. Nearly 88 percent of food handlers had never undergone food safety training. There is a need for the right training intervention program as the gap between the law makers and the followers is big. The loss due to water and food poisoning can affect the economy of the country through direct effect like medical expense, absenteeism, unhealthy human resource and waste of valuable resources resulting in increase of carbon footprints in the food chain.

Keywords: Food Safety; Food Handlers; FSSAI; Training; Food Poisoning.

Introduction

Food is nourishment. Eating the right kind of food at home and outside is important for good health. Eating habits of human beings have evolved with time and with the present lifestyle constraints our dependency on food cooked outside home has increased. Right handling of food at home and commercial establishment is important for wholesome and safe food. It is easier to handle food at home since procurement, cooking and serving is limited to small numbers in comparison to commercial handling. In commercial set ups Food business operators (FBOs) require adequate understanding of food safety along with culinary skills to ensure customer satisfaction and compliance fulfilment. India has a rich culinary expertise as well as many hotel management institutions to train food handlers on the culinary skills. Food Safety and Standards Authority of India (FSSAI) regulations has been implemented in 2012 in India. The government is creating awareness in this regard as it is a mandatory compliance requirement to run a FBO. This means that the government has to market the regulations, strengthen policies, regulate the frame work and ensure adequate enforcement of standards under FSSAI along with support from all municipalities based on market structure [1].

A transparency in the food chain helps in ensuring traceability. The tracking mechanism can help in identifying early warnings and avoid food poisoning [2]. Episodes of food poisoning are common to all countries regardless of its development stage and in most cases is due to inadequate training provided to food handlers. There are so many cases of food poisoning that at times it becomes a part of everyday life [3].

The malpractices followed due to lack of training is known as a major cause of food borne illness among customers and food handlers themselves. Studies

Author's Affiliation: *Research Scholar (PhD), **Professor (Retired), Department of Food Science and Nutrition, University of Mysore-570006, Karnataka, India.

Corresponding Author: Mamatha Mishra, Research Scholar (PhD), Department of Food Science and Nutrition, University of Mysore-570006, Karnataka, India.
Email: mamatha@health1stservices.com

Recieved on 02.06.2017, **Accepted on** 28.06.2017

have shown that the training was inaccessible as it came at a cost and required time. Most of the food handlers are uncomfortable with formal training [4]. Without knowledge on the basics of scientific food handling methods, it is not possible to achieve food hygiene which is a critical part of food safety.

With rapid growth in industrialization and globalization, it is critical that the people involved in entire food chain be trained to achieve the vision to food safety. This includes the training of food handlers too. It is important to understand their education level to develop the right aids for their training. Since the education level varies from being illiterate to basic schooling or higher studies, it helps determine the approach required to train them. They need trainings on the food chain, food preparation, global food – urbanization, changing customer demand to name a few. The trainings are aimed at improving the knowledge, attitude and practice of the food handler [5]. Hence, the present study was planned to understand the level of education and training among food handlers from different type of catering establishments, which could serve as a future database to develop appropriate training materials in food safety.

Material and Methods

The present study was undertaken to determine the status of education and trainings in Food Handlers in the city of Bangalore. There were 16 FBO's identified that included seven medium size restaurants, two catering establishments serving cooked food away from the base kitchen, one school, one hospital and a food court that consisted of six tuck shops. Data was collected with regard to the education and training undergone by the FH and a total of 284 food handlers from all FBO's were studied.

A questionnaire regarding the classification of the FBO, the department of work, literacy, qualification and whether the FH had undergone training or not was framed. The FBO was classified based on whether it was a medium size restaurant, catering establishment, school, hospital or a tuck shop in food court. The FH based on department of work were classified as Cashier, Chef, Helper, Service, Storekeeper, Washing & Cleaning and Manager. The literacy was classified as literate or illiterate. The education classification was Illiterate, Primary school, Middle school, Secondary school, Senior Secondary school and Graduate. The training was captured as rarely or never.

The questionnaire was filled up on a one on one interview with the food handlers. The data is then analysed for the distribution of food handlers in various departments, the relationship between the levels of education in each of the department of work, between the food handlers of the same department, distribution of literates and illiterates and the food safety training undergone to understand and infer on the future training requirements.

Result and Discussion

The results of the study are summarized in Figures 1-4 and Table 1. Figure 1 shows the distribution of food handlers in various food departments. The personnel coming under 'Chef' and 'Service' departments were the highest number covering more than 50 percent of the total food handlers followed by 'Washing & Cleaning' at 17 percent, 'Helpers' at 14 percent, 'Managers' at 7 percent, 'Cashier' at 5 percent and 'Storekeeper' at 3 percent. These data tell us that the maximum number of employees belong to these two departments in any catering unit, and thereby are most important for working of the unit. They also are involved in maximum food handling as they undertake the job of cooking and serving. In India studies have shown that there has been a concern for food safety but limited effort has gone into controlling it. Though World Health Organization has considered food safety as an integral part of health there is still a lot of work required to strengthen this system [6]. Training plays a critical role in food safety. All work departments need to undergo training which includes basic and work specific. It has been observed that the meaning of 'risk' and 'hazard' is not understood by most of the food handlers. The knowledge of the each department of work on the responsibility they hold has to be specified. The subject should be relevant to their area of work so they are open about learning of compliance and safety [7]. The information on the distribution thus was helpful to understand the course material specifically required for training each department and the allotment of time for each of the department.

The distribution of all food handlers based on educational level given in Figure 2 shows that the highest number of food handlers were middle school educated followed by secondary, senior secondary, primary and graduates. An important point to be noted was an overall 17 percent were illiterate. This leads us to a point on the content of the food safety course material. It has been established that an effective course material can instil a positive attitude

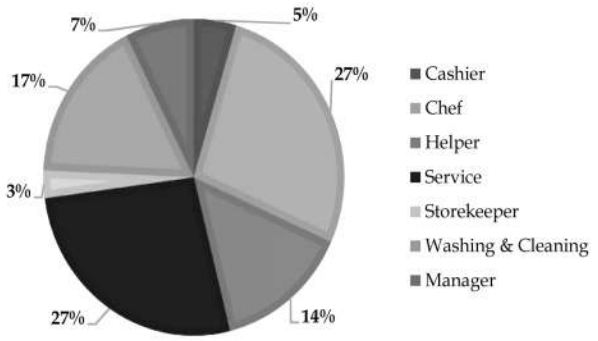


Fig. 1: Distribution of all food handlers in different departments

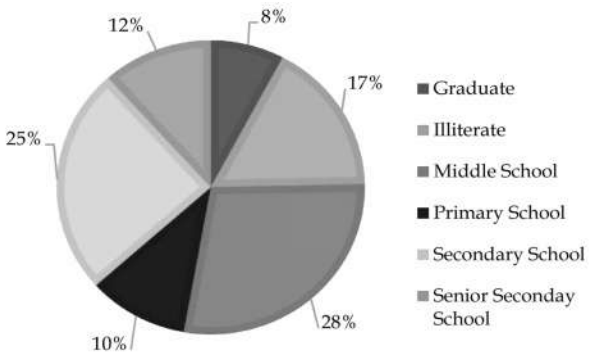


Fig. 2: Distribution of all food handlers based on educational level

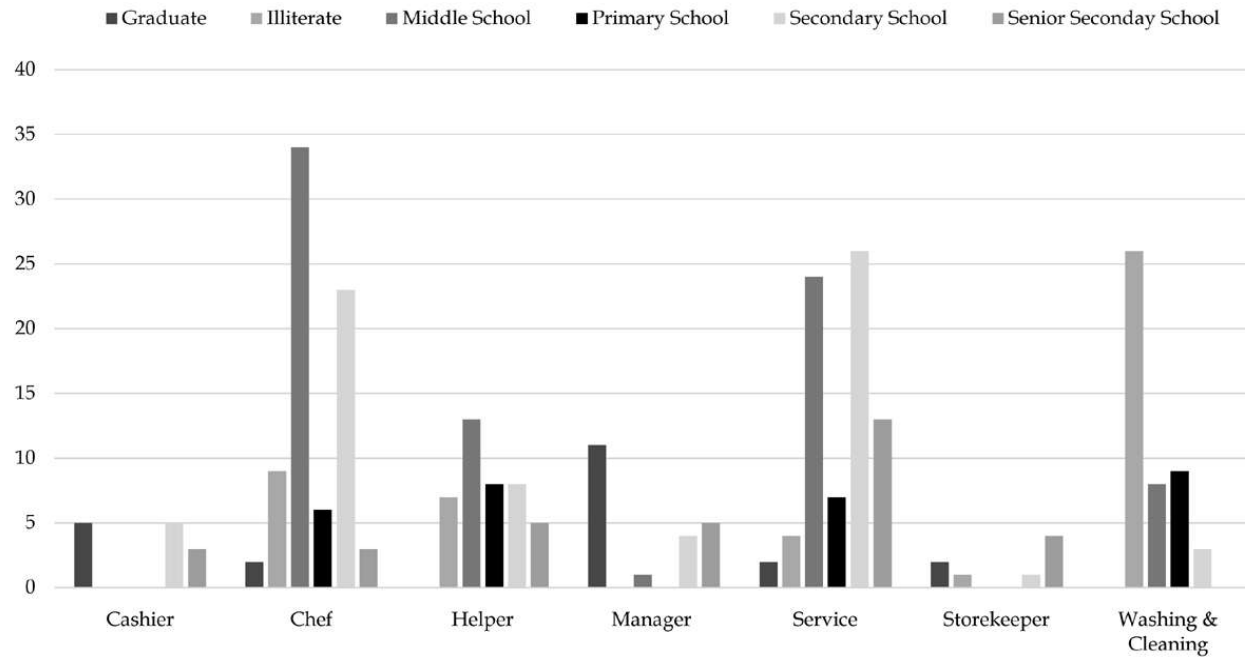


Fig. 3: Distribution of food handlers in different department based on educational level

among food handlers leading to better food safety practices personally like personal hygiene and food handling at all stages of operations [8].

A study conducted in 2011 in Tamil Nadu showed that the 47% of chef's and waiter's carried food poisoning bacterium in their hand and the percentage rose to 87 percent in case of street hawkers. The risks associated with low level knowledge of food handlers was observed [9]. To educate the food handlers in the present study their literacy levels was also analysed as number of workers in each department and the results are compiled in Figure 3. As expected the Managers belonged to the category of highest number of educated workers with highest level of graduates, but also had secondary, senior secondary and one illiterate personnel. The managers were also observed to know few basics on food safety. Since this is a group of literate personnel, the education material can be planned accordingly. The cashiers also were all literate, either graduates, or with secondary or senior secondary school education. Their involvement in physical food handling was minimal but was important as the transactions of inventory and sale had to be maintained by them and a training for FIFO (food in, food out) and invoice maintaining is required for them. The chefs were a mix of all but were mostly middle schoolers followed by secondary schoolers. A classroom session followed by an on the job training would suite them the best. The helpers were both literate and illiterate. Among the literates, higher percentage were middle school educated. Since they were directly involved with helping the chef, they require a training for food handling and also support activities like washing and servicing. The service staff had very few illiterate, most of them were educated expect four. There were few graduates and

senior secondary schoolers, a high percentage of middle school and secondary followed by primary. Since service staff are directly involved in interaction with customers, an overall class room session with on the job training is appropriate for them. The washing and cleaning staff had more than 50 percent illiterate members and this meant that their training had to be through videos and on the job trainings.

The total number of study subjects could be divided as 83% literate with having any level of education and the rest (17%) were illiterate. Specifically the highest number of illiterates were in washing & cleaning department, followed by chef, helpers, service and store as shown in Figure 4. This is one of the factors limiting them to follow food safety practices. This is further affected with the low socio background they come from and the lack of basic awareness of hygiene and safety [10].

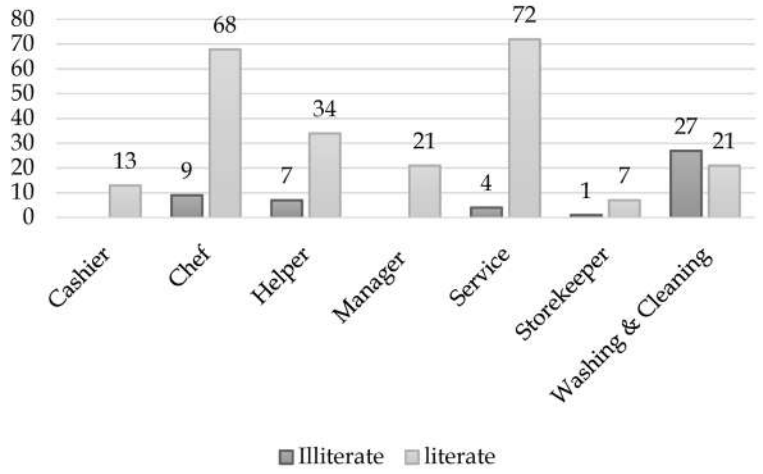


Fig. 4: Number of literate and illiterate in different department

The level of training undergone on food safety was studied for the study subjects and as shown in Table 1, nearly 88 percent of food handlers had never undergone food safety training. It is known that formal food training is required at all levels to implement and sustain food safety. Access to information from the appropriate source in an appropriate format is critical [11]. Since a huge percentage have never been exposed to training, the material built should be basic and then advanced to accommodate all the challenges like small/big FBO's, literate/illiterate and department of work.

Table 1: The number of subjects who attended any training of food handling based on catering unit

Department of Work	Never Attended Training	Rarely Attended Training
Catering	60	8
Food Court	47	8
Hospital	14	-
Restaurant	123	18
School	6	-
Grand Total	250	34

Conclusion

With the rapid speed at which the economy is growing and the opportunity available for the food industry, it is critical that the government supports in the ensuring compliance. Loss due to water and food poisoning can affect the economy of the country through direct effect like medical expense, absenteeism, unhealthy human resource and waste of valuable resources resulting in increase of carbon footprints in the food chain. There is a need for the right intervention as the gap between the law makers and the followers is big. The biggest challenge for food safety failure is the lack of foundation which is the lack of awareness among the food handlers. There is a need to build a training system/module that covers and helps in overcoming the challenges of low awareness, illiteracy/low literacy levels, demographic trends and other factors at the FBO's affecting the implementation of food safety management system. The approach needs to be simple and studied systematically to understand the

effectiveness for successful food safety management system.

Reference

1. Deininger DU, Sur M, Food Safety in a Globalizing World: Opportunities and Challenges for India, Plenary paper prepared for presentation at the International Association of Agricultural Economists Conference. Aug 2006.p.12-18.
2. Beulens JMA, Broens DF, Folstar P, Hofstede JG, Food safety and transparency in food chains and networks Relationships and challenges. Food Control. 2005; 16:481–486.
3. Motarjemi Y, Kaferstein F, Food safety, Hazard Analysis and Critical Control Point and the increase in foodborne diseases: a paradox? Food Control. 1999;10:325-333.
4. Worsfold D, Griffith CJ, A survey of food hygiene and safety training in the retail and catering industry. Nutrition & Food Science. 2003;33(2):68-79.
5. Anuradh M, Dandekar RH, Knowledge, Attitude and Practice among food handlers on food borne diseases: A hospital based study in tertiary care hospital. International Journal of Biomedical and Advance Research. 2014;5(4):196–198.
6. Rao S, Vemula R, Kumar N, Polasa K, Foodborne diseases in India – a review. British Food Journal. 2012;114(5):661-680.
7. Yapp C, Fairman R, Factors affecting food safety compliance within small and medium-sized enterprises: implications for regulatory and enforcement strategies. Food Control. 2006;17:42–51.
8. Arcury TA, Estrada JM, Quandt SA, Overcoming language and literacy barriers in safety and health training of agricultural workers. J Agromedicine. Jul 2010;15(3):236–248.
9. Website Information - Many waiters carry germs on hands: Study, Available on http://timesofindia.indiatimes.com/india/Many-waiters-carry-germs-on-hands-Study/articleshow/15334043.cms. (Downloaded on 29/05.2017).
10. Bhattacharjya, H., Reang, T., Safety of street foods in Agartala, North East India, Public health. 2014;128: 746-748.
11. Jia, C., Jukes, D., The national food safety control system of China, A systematic Review. Food Control. 2013;32:236-245.

Subscription Form

I want to renew/subscribe international class journal **"International Journal of Food, Nutrition & Dietetics"** of Red Flower Publication Pvt. Ltd.

Subscription Rates:
• Institutional: INR5000/USD357

Name and complete address (in capitals): _____

_____

Payment detail:
Ch/Dd No.
Date of Ch/DD
Amount paid Rs./USD

1. Advance payment required by Demand Draft payable to Red Flower Publicaion Pvt. Ltd. payable at Delhi.
2. Cancellation not allowed except for duplicate payment.
3. Agents allowed 10% discount.
4. Claim must be made within six months from issue date.

Mail all orders to
Subscription and Marketing Manager
Red Flower Publication Pvt. Ltd.
48/41-42, DSIDC, Pocket-II
Mayur Vihar Phase-I
Delhi - 110 091(India)
Phone: 91-11-45796900, 22754205, 22756995, Fax: 91-11-22754205
E-mail: sales@rfppl.co.in

Original Article

International Journal of Food, Nutrition and Dietetics
Volume 5 Number 2, May - August 2017
DOI: http://dx.doi.org/10.21088/ijfnd.2322.0775.5217.4

Acceptability Profile of Tomato Soup Prepared Using Flavor Potentiator and Spices

Prabhavathi S.N.*, Jamuna Prakash**

Abstract

Flavor enhancer is widely used in various cuisines to enhance the original flavor or taste in a food system. The most commonly used flavor enhancers in Asian cuisine are the glutamate related compounds such as monosodium glutamate (MSG) , monopotassium glutamate and ribonucleotide based compounds. The present study was planned with an objective of evaluating the flavor potentiating effect of monosodium glutamate on tomato soup. Five soup formulations were prepared using spice powders (*Capsicum annum L., Capsicum fructescens L., Syzygium aromaticum L., Cinnamomum verum, C.* and *Piper nigrum L.*), employing three different levels of MSG (50, 100 or 150mg/100g). Products without MSG served as control. The products were evaluated by trained panelists (n=10) using a score card comprising a maximum score of 20. The results revealed that there was a gradual increase in the scores being awarded for each increasing level of MSG incorporation. Statistical analysis indicated a significant difference in taste, mouth feel and aroma quality of the formulated products. This implies that MSG with spices would tend to have a synergistic effect which in turn contributes for the enhanced liking of the product.

Keywords: Sensory Attributes; Monosodium Glutamate; Spices; Sensory Scoring; Free Choice Profiling.

Introduction

Flavor is considered as one of the most important sensory attribute. Flavor enhancers are the ingredients which by its unique synergistic property would tend to intensify the flavor profile of a product. One of the most common ingredients that have been used as a flavor enhancer since time immemorial is the monosodium glutamate (MSG). It has been identified as the source of *umami* taste for obtaining pleasant savoury taste (Ikeda 2002). Another major advantage of addition of MSG to dishes is that it would serve to reduce sodium content without drastically affecting taste and pleasantness of foods when they are used alone or in combination with Inosine 5′ monophosphate (IMP) (Carter et al 2011a; Okiyama and Beauchamp 1998; Roininen et al 1996). There is a common notion that the umami rich foods are usually regarded as satiating. For instance, sweet taste would exert influence signaling for high energy sources, while that of umami substances might have profound influence on amino acids and proteins (Chawdhari and Roper 2010). Findings from Marsh et al (2007) indicated that, the taste sensitivity to MSG has been thought to be linked with an increased demand for dietary protein.

Several researchers have also reported that, MSG is likely to interact with protein, and can influence gastric emptying leading to subsequent altered appetite and energy intake (Marsh et al 2009; Masic and Yeomans 2013; Zai et al 2009). MSG is also known to have greater impact on satiety which is mainly due to the presence of umami taste receptors and its signaling molecules and their expression in gastro intestinal enteroendocrine cells (Nakamura et al 2010; Gabriel et al 2007). Incorporation of glutamate has been estimated to stimulate these cells, consequently promoting the release of satiety related hormone such as cholecystokinin and glucagon like peptide both in rodents as well as in humans (Daly et al 2013; Hosaka et al 2012). The synergistic interactions of free glutamate and 5′-ribonucleotides are known to be the major determinants of intensity of umami taste in any product. A significant enhancement in umami taste

Author's Affiliation: *Research scholar **Rtd. Professor, Department of Studies in Food Science and Nutrition, University of Mysore, Mysuru, 570006, Karnataka, India.

Corresponding Author: Prabhavathi S.N., Department of Studies in Food Science and Nutrition, University of Mysore, Mysuru. 570006, Karnataka, India.
E-mail: pprabhavathisn@gmail.com

Recieved on 18.05.2017, **Accepted on** 13.06.2017

could be brought about by 5'ribonucleotides. This unique taste property is termed as taste synergism (Zhang et al 2008). Investigations of Marcus (2005) and Peralta et al (2005) have indicated that, most of the processed savoury foods have been reported to contain umami substances which are mainly released during various processing steps such as ripening, drying, curing, aging and or fermentation. The objective of the present investigation was to examine the flavor potentiating effect of MSG in tomato soups prepared with different spices.

Methodology

For the preparation of soups the materials such as full ripe tomato (*Lycopersican esculentum*), corn flour (*zea mays*), milk, salt and five different spices namely; two varieties of chillies- chilli CA (*Capsicum annum L*), chilli CF (*Capsicum fructescens* L), pepper (*Piper nigrum L*), cloves (*Syzygium aromaticum* L) and cinnamon (*Cinnamonum verum C*) were procured from local market. These spices were ground into desired particle size prior to incorporating into soups. The two different varieties of chillis used in soup formulation are known to have varied level of pungency. Chilli CF is known to impart a bright appealing color with an appetizing delicate aroma, while chilli CA has higher pungency. Hence, they contribute for the different flavor profile to whatever dishes they may be added. MSG was obtained from Ajinomoto company, Japan.

Preparation of the Soup

Fresh full ripe tomatoes were washed, blanched and the skin was removed. The pulp was ground into a fine paste and was strained. This pulp was used for the preparation of soup. The basic soup recipe was developed by using 75g of ground tomato pulp, 0.5g corn flour and 25ml milk. The level of addition of spice powders, namely chilli CA, chilli CF, pepper, cinnamon and cloves was standardized individually to give the soup a pleasant flavour. Each of the selected spice powders were added at the level of 0.2, 0.4, 0.2 0.05 and 0.1g respectively per 100g of the prepared soup samples. The soups were standardized with three different levels of MSG (100, 150 and 200mg) and the one without MSG served as control sample. For each sample 1g salt was added. A white sauce was prepared by adding corn flour to boiled and cooled milk. To this mixture tomato pulp was added and was cooked on medium flame for 5 min with constant stirring. Towards the end of cooking, spice powders and desired level of salt and MSG were added, mixed well.

Sensory Evaluation

The prepared soup samples were subjected to sensory evaluation by a total of 10 trained panelists. The sensory panelists were recruited by various sensory screening tests and were selected based on their ability to perceive and detect the flavor of MSG when the samples were presented in a solution comprising various basic tastes. Multiple training sessions were completed using taste solutions of all basic tastes for intensity scaling. The concentration of salt solutions used for testing were 0.05, 0.1, 0.15 0.2, 0.25 and 0.3% and for sour solution [represented by citric acid] were 0.01, 0.03, 0.05, 0.07, 0.09 and 0.11%. The grading scale used was : 0- none or taste of pure water, ?-different from water but taste quality not identifiable, X-very weak taste, 1- very weak taste, 2-medium, 3- strong, 4- very strong, 5- extremely strong. Tests were conducted pre- and post MSG to bring out the flavor potentiating effect of MSG on basic taste.

For soup samples, a maximum score of 20 was assigned for the various sensory attributes such as appearance, taste, mouth feel, aroma and overall acceptability. The grading scale was defined as follows; 1-4 fair, 5-8 satisfactory, 9-12 good, 13-16 very good, 17-20 excellent. An additional score card was also used to evaluate the free choice profiling of the soup samples. The characteristic attributes of the sample was evaluated in a descriptive manner.

Statistical Analysis

The results obtained through sensory evaluation were subjected to statistical tests to derive mean and SD. The scores of sensory attributes were subjected to analysis of variance (ANOVA) to determine statistical significance at p = 0.05% using data analysis tool pack.

Results and Discussion

The results of the study are compiled in Figures 1-2 and Tables 1-2.

Flavour Potentiating Effect of MSG on Basic Tastes

Since, MSG is known to have flavor enhancing effect, results of sensory threshold testing for salt and sour taste were selected for inclusion as they have

a direct relation with the flavour attributes of tomato soup. Data pertaining to cumulative responses for threshold tests for salt is presented in Figure 1. Majority of the panel members were able to identify the taste quality at different intensities as weak, medium and strong. For very few panel members the perception was found to be towards very strong. The responses were found to be nil for the intensity scale indicating extremely strong taste of the given solution. The results of after effect of MSG on the perception of salt taste (salt post MSG) showed that MSG did not exert a masking effect on the perception of basic taste quality which was evident from the compiled results. A very small number of panel members were still able to perceive the basic taste quality as being different from water [5] and a perception of very weak threshold [8]. For considerably higher number of panel members the taste intensity was found to be in the range of weak to very strong. According to the responses of 3 panel members it was opined to have extremely strong taste. Similarly the responses obtained for mixed solution i.e. MSG +salt showed that the taste perception was better in the presence of MSG because it exerts synergism with salt. Here, a proportionately higher number [20] of panel members were found to be more sensitive to salty taste and thus the responses obtained were shown to be towards

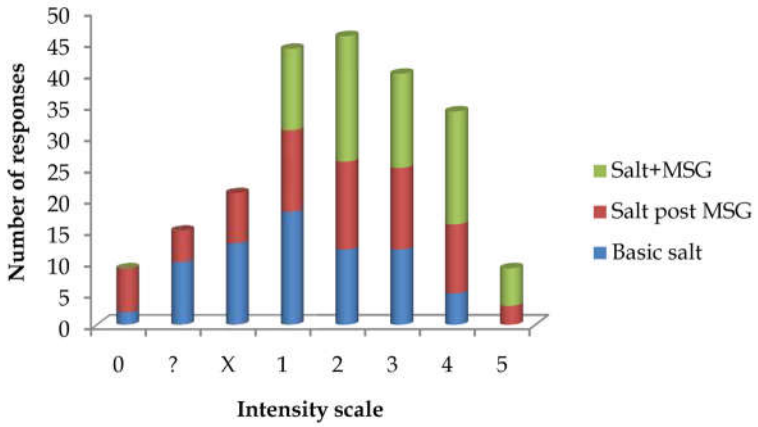


Fig. 1: Cumulative responses for threshold tests for salt

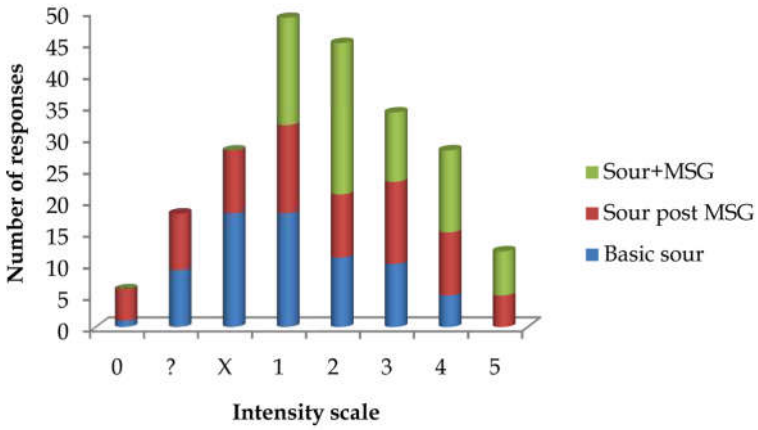


Fig. 2: Cumulative responses for threshold tests for sour

the higher category of intensity scaling.

Grading scale: 0- none or taste of pure water, ?- different from water but taste quality not identifiable, X-very weak taste, 1- very weak taste, 2-medium, 3- strong, 4- very strong, 5- extremely strong.

Citric acid was used to prepare the solution representing the sour taste. The threshold responses for basic sour taste and sour post MSG are presented in Figure 2. For the basic sour taste majority of the respondents identified the taste as either bland or to be very weak. The observed responses were found to be spread over a wide range of intensity scaling ranging from unrecognizable level to extremely strong

taste. The compilation of the responses implied that there was a gradual progress in the recognition of the given taste which showed an increase from being weaker to stronger category.

A similar trend was observed in taste perception of sour solution which was tasted after MSG solution. According to the responses it can be said that there was no carry over/taste masking effect. Here a proportionately higher number of panel members were able to recognize the taste quality. This shows that sour taste could be very easily recognized in comparison to salt even at a lower intensity scale. This could be due to the characteristic sharp tangy taste of the citric acid to which most humans are found to be sensitive and can be recognized very easily. In this case also the results were found to be widely distributed throughout the entire intensity scaling ranging from very weak to extremely strong. A slightly higher number of responses were found to be distributed in the intensity scale of ? and X.

The results of mixed solution of MSG and sour taste indicated that majority of the responses were found as having a medium taste perception (24), followed by weak (17), strong (11), very strong (14) and extremely strong taste (7). This indicates that even after mixing with MSG the basic sour taste was able to maintain its characteristic taste and flavor. All the recorded responses were towards the progressive higher range of intensity scaling.

Effect of MSG Addition on Sensory Quality of Tomato Soup

The mean sensory scores of tomato soup prepared with chilli CA and chilli CF, pepper, cinnamon and cloves are presented in Table 1. The mean scores for the quality of appearance were found to be similar for various samples with two different varieties of chillies. For chilli CA the score was 14.8±1.33 and for soup with chilli CF 12.5±1.43. Statistical analysis indicated p-value greater than 0.05 implying that the appearance of soup samples was not affected due to the addition of MSG. The mean scores for all the other attributes of control sample were found to be comparatively lesser than that of samples prepared by incorporating MSG. The taste quality of sample with chilli CA was indicated to have obtained gradually increasing level of scores which ranged between 10.1±1.3 – 13.2 ±1.23 respectively. Statistical

Table 1: Sensory scores [Mean ± standard deviation] for tomato soup

Appearance	Chili CA	Chili CF	Pepper	Cinnamon	Clove	ANOVA
Control	12.5± 1.43	14.8 ± 1.33	13.3± 1.73	11.6± 1.56	11.2± 1.33	3.61^{NS}
100	12.5± 1.43	14.8 ± 1.33	13.3± 1.73	11.6± 1.56	11.2± 1.33	3.61^{NS}
150	12.5± 1.43	14.8 ± 1.33	13.3± 1.73	11.6± 1.56	11.2± 1.33	3.61^{NS}
200	12.5± 1.43	14.8 ± 1.33	13.3± 1.73	11.6± 1.56	11.2± 1.33	3.61^{NS}
p-value	1.000	1.000	1.000	1.000	1.000	
Taste						
Control	10.65± 1.58	10.1± 1.3	12.6± 1.43	11.4 ±1.56	11.5± 1.43	0.01*
100	11.5± 1.43	11.3± 1.36	13.35± 1.42	12.45± 1.59	12.6± 1.28	0.02*
150	12.4 ±1.02	12.15± 1.34	14.6 ±1.34	13.35± 1.55	13.45± 1.11	0.001**
200	13.3± 1.10	13.2 ±1.23	15.4 ±1.43	14.5± 1.36	14.3 ±1.19	0.003**
p-value	0.00085	0.00013	0.0006	0.0009	0.0002	
Mouth feel						
Control	11.75± 1.29	10.65± 1.45	11.5 ±1.28	11.6±5 1.42	11.2± 1.6	0.48^{NS}
100	12.78± 1.38	11.8 ±1.31	12.55± 1.31	12.7± 1.23	12.35± 1.69	0.58^{NS}
150	13.8 ±1.33	12.75± 1.19	13.6 ±1.26	13.55 ±1.31	13.1± 1.58	0.46^{NS}
200	14.4 ±1.56	13.55± 1.15	14.3± 1.19	14.4 ±1.28	13.9 ±1.3	0.56^{NS}
p-value	0.0013	0.00019	0.00021	0.0006	0.005	
Aroma						
Control	12.3± 1.35	10.7± 1.62	11.3± 1.28	12.25 ±1.36	10.8 ± 1.33	0.03*
100	13.25± 1.36	11.75± 1.44	12.35 ±1.10	13.2± 1.33	11.9 ±1.39	0.05*
150	14.23± 1.37	12.65± 1.45	13.15± 1.10	14.15 ±1.34	12.7± 1.40	0.02*
200	15.3± 1.35	13.8 ±1.40	13.7± 0.81	15.05± 1.31	13.3 ±1.36	0.004**
p-value	0.00029	0.00068	0.0017	0.0005	0.0029	
Overall acceptability						
Control	11.2 ± 1.33	11.65± 1.18	11.65± 1.18	11.95± 1.31	11.9± 1.45	0.10^{NS}
100	12.3± 1.27	12.6± 1.11	12.6± 1.11	13.0 ±1.26	13.05±1.27	0.12^{NS}
150	13.3± 1.17	13.4± 1.20	13.4± 1.20	13.9± 1.30	14±1.26	0.16^{NS}
200	13.95± 0.93	14.2± 1.25	14.2± 1.25	14.9± 1.30	14.8 ±1.33	0.19^{NS}
p-value	0.0001	0.00045	0.00045	0.0002	0.0003	

Note: P value indicates effect of MSG on taste attribute of samples whereas ANOVA indicates comparison between different spices

analysis revealed highly significant differences (p=0.00013). A similar trend in the pattern of score being given for other attributes was observed. The differences were found to be statistically highly significant. Chilli CA was known to impart a delicate pungent aroma to the soup samples which was reported to enhance the aroma characteristics. The incorporation of MSG resulted in a synergistic effect and a gradually increasing level of score was awarded for the various soup samples.

For soups prepared with chilli CF, samples with 200mg of MSG was found to be given the highest score (13.3 ± 1.10). For the quality of aroma the scores given were in the range of 12.3 – 15.3. Statistically highly significant differences were noted for the attributes like taste (p=0.00085), aroma (p=0.00029) and overall quality (p=0.00011). While mouth feel was evaluated to have only a mild significant differences (p=0.0013). A similar trend in the pattern of score being given for other attributes was observed. The differences were found to be highly significant. Chilli CA was known to impart a delicate pungency to the soup samples which was reported to enhance the aroma characteristics. The incorporation of MSG resulted in a synergistic effect with a consequent gradual increase in the scores of the soup samples with different levels of MSG.

For soups prepared with chilli CF, sample with 200mg of MSG was found to be given the highest score (13.2 ±1.23) for its taste quality. For the quality of aroma the scores given were in the range of 10.7± 1.62 -13.8 ±1.40 respectively. Statistically significant differences were noted with respect to attributes like; taste (p=0.00013), Mouth feel (p=0.00019), aroma (p=0.00068) and overall acceptability (p=0.00037).

As can be seen from the table, the soups prepared with pepper powder was found to have obtained highest scores for the quality of taste (15.4 ± 1.43) in comparison to soups prepared with cinnamon (14.5 ±1.36) and cloves (14.3 ±1.19). Appearance quality was shown to have statistically non significant difference for all the three different set of samples. For aroma quality of pepper soup, cinnamon and cloves the scores given were in the range of 11.3-13.7, 12.25-15.05 and 10.8 – 13.3 respectively. Among all the soup samples soup with cloves was found to have scored proportionately lower scores. The control samples from all the three sets were found to have been awarded comparatively lower scores. Within each set, the control product was found to have scored much lower scores for its overall acceptability in comparison to products with MSG. Considerable variations were observed within each set of samples for the attributes of taste, mouth feel, aroma and overall acceptability. A similar trend in the scoring pattern was observed for all the 3 set of products, i.e, as the level of MSG increased the scores were also found to be given in an increasing trend. This is suggestive of the fact that, MSG incorporation along with different spice powders was shown to exert flavor synergism with a consequent increase in the perceived level of palatability. Statistically highly significant differences were noted for all the attributes of three different set of products.

The analysis of variance was performed in order to determine whether there exists any inter sample differences when compared with different levels of MSG and with spices. The inter sample comparison indicated that the difference was not significant for the appearance quality (p=3.61) of all the samples with different levels of MSG and spices. With respect to taste quality all the formulated soup samples were exhibited to have mild to moderate level of differences. Control sample and sample with 100mg MSG were found to have very mild significant differences (p=0.01 and 0.02). While for product with 150 and 200mg MSG it was indicated to have moderate differences with the probability value of 0.001 and 0.003 respectively. With the available data it can be inferred that with increasing the concentration of MSG the product would acquire better taste quality in comparison to those made without incorporating MSG. The quality of mouth feel was shown to have no significant differences for all the soup samples with different levels of MSG and spices. For the quality of aroma the statistical analysis indicated significant differences. For control sample (p=0.03), and sample with 100 and 150mg MSG (p=0.05, 0.02). The differences were observed to be quite large (p=0.004) for product with 200mg MSG. This data implies that MSG incorporation tended to enhance the aroma characteristic. The analysis of overall acceptability data showed no significant differences between all the developed soup samples. From the above observations it can be concluded that certainly there was a significant improvement in taste and aroma characteristics. This could be because MSG is basically known as an excellent flavor potentiator and its role has been clearly demonstrated in the present investigation via enhancement in taste and aroma quality.

A study was conducted by Kang et al (2007) to evaluate the sensory interactions of organic acids and various flavours in ramen soup systems. There are basically three types of ramen soup bases namely; beef, sea food and kimchi flavours that are considered as most popular flavor bases for ramen soup in South Korea. These were selected as model food system for

evaluating the potential of organic acids such as malic, citric and lactic acid as flavor enhancers. The results of the sensory characteristics of 'beef' ramen soup showed that the intensity of all the attributes except for fat and MSG taste indicated to have significant differences. In 'seafood' ramen soup system the intensity of hot, sweet taste, salty, MSG taste, dried shrimp, mussel dried seaweed were indicated to have no significant differences. The addition of acid tended to increase the sourness but was shown to have least effect on other flavor attributes. The addition of organic acid to kimchi soup resulted in an increase in astringent, hot, sour taste and metallic taste. But, tended to decrease sweet taste, MSG taste, artificial beef flavor and mushroom flavor. In this particular formulation the flavor attributes generally known to have congruency with sourness such as astringency and metallic tastes which were seem to be enhanced with the addition of organic acids. On the other hand, the attributes not exerting congruency such as sweet, MSG, artificial beef and mushroom flavor were shown to be suppressed. The authors concluded that, the sour flavor intensification was thought to be largely dependent on the congruency of the pair in each of the specific food systems.

Kawai et al (2012) investigated the glutamate concentration in miso soup served in hospitals and nursing homes for the elderly in Japan. This traditional savoury soup is very popular in Japan which is served at least once a day in such institutions. It is generally prepared by boiling ingredients such as vegetables in soup stock (dashi) and then seasoning the stock with fermented soybean paste (miso). The collected soup samples were analyzed for glutamate concentration, Disodium inosine 5′ monophosphate(IMP) and Disodium-5'-guanosine monophosphate **(**GMP) and sodium content. The results showed that the glutamate concentration in samples ranged from 36±4.0 to 98± 7.0mg/100ml. The variation in glutamate concentration within each institution was noted to be relatively small. The estimated concentration of IMP was 8.8±8.5mg/100ml, while, that of GMP was 1.6±3.1ml/100ml. These two substances are known to exert synergistic effect especially when mixed with glutamate. The sodium concentration was observed to fall within a narrow range of 142 and 596 mg/ 100g. A significant positive correlation was noted between the glutamate and sodium concentration. Miso is known to contain high glutamate and sodium since it is prepared with salted and fermented soybeans. Readymade dashi contains higher concentration of glutamate and sodium as it comprises sodium chloride and umami compounds

Table 2: Free choice profiling of tomato soup prepared using different spices

Sensory Attributes	Chili CA				Chili CF				Pepper				Cinnamon				Clove			
	Level of MSG (mg/100g)				Level of MSG (mg/100g)				Level of MSG (mg/100g)				Level of MSG (mg/100g)				Level of MSG (mg/100g)			
	Con.	100	150	200	Con.	100	150	200	Con.	100	150	200	Con.	100	150	200	Con.	100	150	200
Appearance																				
Appealing	7	6	8	6	7	6	6	8	9	9	9	9	10	10	10	10	10	10	10	10
Attractive	3	4	2	4	3	4	4	2	1	1	1	1	-	-	-	-	-	-	-	-
Taste																				
Appetizing	4	8	7	5	8	9	8	7	6	8	8	8	6	8	7	5	7	8	6	7
Pleasant	6	2	3	5	2	1	2	3	4	2	2	2	4	2	3	5	3	2	4	3
Aroma																				
Delightful	8	9	7	6	8	7	9	6	8	7	5	6	8	9	6	7	8	7	4	9
Very mild	2	1	3	4	2	3	1	4	2	3	5	4	2	1	4	3	2	3	6	1
Consistency																				
Smooth	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Overall acceptability																				
Delicious	3	6	5	8	6	7	9	8	6	7	8	8	9	7	8	6	6	9	7	8
Appetizing	7	4	5	2	4	3	1	2	4	3	2	2	1	3	2	4	4	1	3	2

Con.: Concentration.

as major ingredients. The positive correlation between the concentration of glutamate and sodium in miso soup could be due to the wide variety of associated aspects of miso soup.

The information pertaining to responses for descriptive quality attributes given under free choice profiling of soups prepared with Chilli CA and Chilli CF, pepper, cinnamon and cloves is indicated in Table 2. As can be observed from the table, all the products were rated to be 'appealing' and 'attractive' for the quality of appearance. Taste profile showed that all the products were perceived as 'appetizing and pleasant'. For the quality of aroma highest number of response was obtained for 'delightful' followed by very few responses stating as 'very mild' perception. Similarly for soup with chilli CA obtained higher responses for the appearance attribute under appealing and a few responses reporting as 'attractive'. Consistency was rated as 'smooth' and overall acceptability as delicious and appetizing.

In general the overall responses obtained for the soups were as follows: majority of the responses indicated the soup to be appealing followed by 'attractive'. Taste was reported to be appetizing by majority of the panelists. While, a small number of responses were also recorded as pleasant. Aroma quality was regarded as delightful by most of the panelists and very few reported it to be as very mild for all the three set of soups. Considerably higher number of subjects responded as the soup was delicious and appetizing. From the compilation of above responses it can be inferred that the spices would interact with the taste and aroma characteristics with a consequent impact on enhancing the flavor profile of formulated soup samples. Thus it could be said that to have maximum acceptability, spices and MSG combination could be regarded as a better option for achieving consumer acceptability.

Conclusion

The study indicated that the soups formulated with different spice combination with the incorporation of MSG exhibited maximum acceptability as evident with sensory scores. Hence MSG could be used as an additive to bring about enhanced flavor effect along with spice combination, since it is known to exert flavor synergism.

References

1. Carter, B. E., Monsivais, P., & Drewnowski, A. The sensory optimum of chicken broths supplemented with calcium di-glutamate. A possibility for reducing sodium while maintaining taste. Food Quality and Preference, 2011a;22:699–703.
2. Chaudhari, N. & Roper, S.D. The cell biology of taste. The Journal of Cell Biology, 2010;190:285–296.
3. Daly, K., Al-Rammahi, M., Moran, A., Marcello, M., Ninomiya, Y., & Shirazi-Beechey, S.P. Sensing of amino acids by the gut-expressed taste receptor T1R1-T1R3stimulates CCK secretion. American Journal of Physiology. Gastrointestinal and Liver Physiology, 2013;304(3):G271–G282.
4. Hosaka, H., Kusano, M., Zai, H., Kawada, A., Kuribayashi, S., Shimoyama, Y., et al. Monosodium glutamate stimulates secretion of glucagon-like peptide-1 andreduces postprandial glucose after a lipid-containing meal. Alimentary Pharmacology & Therapeutics, 2012;36(9):895–903.
5. Ikeda, K. New seasonings. Chemical Senses, 2002;27(9):847–849.
6. Kawai, M., Hirota, M., and Uneyama, H. (2012). Umami taste in Japanese traditional miso soup for the elderly. J. Nutr. Food Sci, doi:10.4172/2155-9600. S10-005.
7. Luscombe-Marsh, N.D., Smeets, A.J.P.G., &Westerterp-Plantenga, M.S. Taste sensitivity for monosodium glutamate and an increased liking of dietary protein. The British Journal of Nutrition, 2007;99:904–908.
8. Luscombe-Marsh, N.D., Smeets, A.J.P.G., & Westerterp-Plantenga, M.S. The addition of monosodium glutamate and inosine monophosphate -5 to high protein meals. Effects on satiety, and energy and macronutrient intakes. The British Journal of Nutrition, 2009;102(6):929–937.
9. Masic, U. & Yeomans, M.R. Does monosodium glutamate interact with macronutrient composition to influence subsequent appetite? Physiology & Behavior, 2013;116–117, 23–29.
10. Nakamura, E., Hasumura, M., San Gabriel, A., Uneyama, H., & Torii, K. New frontiers in gut nutrient sensor research. Luminal glutamate-sensing cells in rat gastric mucosa. Journal of Pharmacological Sciences, 2010;112(1):13–18.
11. Okiyama, A., & Beauchamp, G.K. Taste dimensions of monosodium glutamate (MSG) in a food system. Role of glutamate in young American subjects. Physiology & Behavior, 1998;65(1):177–181.
12. Roininen, K., Lähteenmäki, L., & Tuorilla, H. Effect of umami taste on pleasantness of low-salt soups during repeated testing. Physiology & Behavior, 1996;60(3):953–958.
13. San Gabriel, A. M., Maekawa, T., Uneyama, H.,

Yoshie, S., & Torii, K. MGluR in the fundic glands of rat stomach. FEBS Letter, 2007;20:1119–1123.

14. Marcus, B.J. Culinary applications of umami. Food Technology, 2005;59(5):24–30.
15. Peralta, E. M., Hatate, H., Watanabe, D., Kawabe, D., Murata, H., Hama, Y., et al. Antioxidative activity of Philippine salt-fermented shrimp and variation of its constituents during fermentation. Journal of Oleo Science, 2005;54(10):553–558.
16. Zhang, F., Klebansky, B., Fine, R. M., Xu, H., Pronin, A., Liu, H., Tachdjian, C., & Li, X. Molecular mechanism for the umami taste synergism. Proceedings of the National Academy of the United States of America, 2008;105(52):20930–20934.
17. Kang, W.M., Chung, S.J., Lee, S.H., Kim, Y., and Kim, K.O. The sensory interactions of organic acid and various flavours in ramen soup systems. Journal of Food Science: 2007;72(9):S639-s647.

Review Article

International Journal of Food, Nutrition and Dietetics
Volume 5 Number 2, May - August 2017
DOI: http://dx.doi.org/10.21088/ijfnd.2322.0775.5217.5

Pomegranate: An Exotic Fruit with Rich Antioxidants

K. Silambuselvi*, V. Muruguvalavan**

Abstract

Pomegranates are being hyped up as a miracle drug since ancient times. It is an exotic fruit having many therapeutic benefits. They are rich source of Antioxidants, Vitamin C, Potassium, Iron, Fiber, and many of phytochemicals compounds which have protective health effects against cardiovascular, oncological. and neurological disorders. Several evidence also suggest that pomegranate have more therapeutic benefits.

Keywords: Pomegranates; Therapeutic Benefits; Antioxidants; Phytochemicals.

Introduction

The pomegranate, botanical name Punica granatum [1]are considered as the 'fruits of paradise' in ancient cultures. They've been found in Egyptian tombs, eaten by Babylonian soldiers prior to battle and incorporated into Persian wedding ceremonies to symbolize a joyous future. From ancient times Pomegranate has been grown widely in parts of the United States, Afghanistan, Russia, India, China, and Japan. It is a rich nutritious fruit with unique taste and flavor and also have many health promoting characteristics. Every part of the pomegranate plant including the fruit juice, peel, arils, flowers, and bark have medicinal values.. Research also indicates that pomegranates and their extracts may serve as natural alternatives due to their potency against a wide range of bacterial and viral pathogens. Various phytochemical compounds in pomegranate have demonstrated antimicrobial activity, but most of the studies have found that ellagic acid and larger hydrolyzable tannins, such as punicalagin, have the highest activities.

Author's Affiliation: *Assistant Professor in Nutrition, S.R.M. College of Nursing, SRM University, Kattankulathur, Kancheepuram-603203, Tamil Nadu, India. *Assistant Professor, Tamil Nadu Physical Education and Sports University, Chennai, Tamil Nadu, India.

Corresponding Author: K. Silambuselvi, Assistant Professor in Nutrition, S.R.M. College of Nursing, SRM University, Kattankulathur, Kancheepuram-603203, Tamil Nadu, India.
E-mail: selvivalavan@gmail.com

Recieved on 20.04.2017, **Accepted on** 09.05.2017

In Unani system of medicine practiced in the Middle East and India pomegranate serves as a remedy for diabetes [2]. Even in Ayurvedic medicine the pomegranate is considered "a pharmacy unto itself". It is used as a "blood tonic, [3] and antiparasitic agent [4] and to heal diarrhea, and ulcers [5]. Several lines of modern scientific evidence also indicates the therapeutic efficacy of pomegranate against different types of disorders [6].

Nutritive Value of Pomegranate

Pomegranate Nutrition Value per 100g
(Source from USDA)

Minerals	Nutrient Value
Calcium	10mg
Copper	18%
Iron	0.30mg
Magnesium	12mg
Manganese	0.119mg
Phosphorus	36mg
Selenium	0.5µg
Zinc	0.35mg

	Nutrient Value
Energy	83 kcal
Carbohydrates	18.70 g
Protein	1.67g
Total Fat	1.17g
Cholesterol	0 mg
Dietary Fiber	4g

Vitamins	Nutrient Value
Folates	38 µ
Niacin	0.293 mg
Pantothenic acid	0.135 mg
Pyridoxine	0.075 mg
Riboflavin	0.053 mg
Thiamin	0.067 mg
Vitamin A	0 IU
Vitamin C	10.2 mg
Vitamin E	0.60 mg
Vitamin K	16.4 µg

Pomegranate is moderate in calories, contains about 83 calories per 100 grams. It has no saturated fats. It is a good source of soluble and insoluble dietary fibers; providing about 4 grams per 100 g. The fruit is also good source of antioxidant *vitamin-C*, provides about 10.2 mg per 100 g. Further, it is also good source of many vital B-complex groups of vitamins such as folates, pyridoxine, pantothenic acid (vitamin B-5), and vitamin K, and minerals like potassium, calcium, copper, and manganese.

Therapeutic Benefits of Pomegranate

The most therapeutically beneficial pomegranate constituents are polyphenols - ellagitannins, ellagic acid (including punicalagins), punicic acid, flavonoids, anthocyanidins, anthocyanins, and estrogenic flavonols and flavones.

Ellagitannin can be broken down into hydroxybenzoic acid such as ellagic acid. Two other ellagitannins that are found in both pomegranate juice and peel are punicalagin and punicalin. Pomegranate juice and peel have catechins with a high antioxidant activity. Level of antioxidants have been found to be higher than in other natural juices and even in red wine. They are so powerful that pomegranate juice has been found to have three times the antioxidant activity of red wine and green tea [7]. It is also widely used in plastic surgeries, which prevents skin flap's death due to its antioxidant activity.

Punicic acid, is a major bioactive neutraceutical compound found in pomegranate seed. A study done in 2014 [8] concluded that Punicic acid is a potential nutraceutical and should be encouraged for use both as a prophylactic and therapeutic agent. Several classes of pomegranate flavonoids include anthocyanins, flavan 3-ols, and flavonols. These are essential compounds of anthocyanin's production with antioxidant and inflammatory role. All pomegranate flavonoids show antioxidant activity with indirect inhibition of inflammatory markers such as tumor necrosis factor-alpha (TNF-α)[9]. Anthocyanins are responsible for the red color of juice.

Pomegranates are Cardio Protective

Antioxidants have numerous positive properties, including protection against cholesterol oxidation, anti-aging effects and protection against atherosclerosis.

Esmaillzadeh A et al [10] assessed the effect of concentrated pomegranate juice consumption on lipid profiles of type II diabetic patients with hyperlipidemia and they found that after consumption of concentrated pomegranate juice significant reductions were seen in total cholesterol ($p < 0.006$), low-density lipoprotein-cholesterol (LDL-c) ($p < 0.006$), LDL-c/high-density lipoprotein-cholesterol (HDL-c) ($p < 0.001$), and total cholesterol/ HDL-c ($p < 0.001$). Their study concluded that pomegranate juice consumption could modify heart disease risk factors in these hyperlipidemic patients.

Another study by Aviram & Dornfeld [11] demonstrated a 5% decline in systolic blood pressure with daily consumption of 50 ml of pomegranate juice for two weeks. Both males and females were studied, with each participant on anti-hypertensive pharmacological therapy. Lowered blood pressure resulted from a direct interaction of the pomegranate juice with serum angiotensin converting enzyme. In a randomized, double-blinded, placebo-controlled study at the Preventive Medicine Research Institute in Sausalito, pomegranate juice drinkers with coronary artery disease had a 17% improvement in blood flow compared with an 18% worsening in the control group. The study team concluded that the antioxidants in the juice may help prevent the formation of fatty deposits on artery walls. Several studies also support that Pomegranate phytochemicals reduce LDL oxidation [12] have blood pressure-reducing properties [13] and many cardioprotective functions.

Anti-Cancer Properties of Pomegranates

Pomegranate's antioxidant activity is known to

inhibit cell proliferation and invasion, and promote apoptosis in various cancer cells [14]. A study also proved that pomegranate extract was found to inhibit the growth of human breast cancer cells by inducing cell death [15]. Pomegranate fruit has been shown to have the inhibitory efficacy against prostate cancer and lung cancer. It can be exploited in chemoprevention and chemotherapy of prostate cancer. A 2013 study examined the anti-cancer efficacy of pomegranate fruit grown in Taiwan against urinary bladder urothelial carcinoma and its mechanism of action. The analytical results of this study help to provide insight into the molecular mechanism of induced bladder cancer cell apoptosis by pomegranate and to develop novel mechanism-based chemopreventive strategy for bladder cancer [16].

A research also demonstrated that pomegranate oil has chemopreventive efficacy in mice. Reduced tumor incidence (7%), decrease in tumor numbers, reduction in ornithine decarboxylase activity (17%), significant inhibition in elevated Tissue plasminogen activator -mediated skin edema and hyperplasia, protein expression of ornithine decarboxylase, and epidermal ornithine decarboxylase activity have been reported with pomegranate oil treatments [17,18].

Adams et al. [19] examined the effects of pomegranate juice on inflammatory cell signaling proteins in HT-29 human colon cancer cell line. At a concentration of 50 mg/l, pomegranate juice significantly suppressed TNFα-induced (COX)-2 protein expression by 79% and also reduced phosphorylation of the NF-κB/p65 subunit and its binding to the NF-κB response element. These data suggest that polyphenolic constituents in the pomegranate can play an important role in the modulation of inflammatory signals in colon cancer cells. Pomegranate also has anti-angiogenic properties, they help to prevent growing tumors from acquiring a blood supply, preventing those tumors from receiving the nutrients that would allow them to grow larger [20,21].

Pomegranate and Osteoarthritis

The most common forms of arthritis are osteoarthritis and is a major progressive degenerative joint disease, which could affect joint functions and quality of life in patients. According to research published in the *Israeli Medical Association Journal* [22] concluded that Pomegranate may help reduce joint pain and decrease inflammation in arthritis sufferers. Arthritis is mediated by proinflammatory cytokines such as IL-1 and TNF-α. MAPKs are important due to their inflammatory and cartilage damage regulation [23] P38-MAPKs are responsible for regulating cytokine production, neutrophils activation, apoptosis, and nitric oxide synthesis. The MAPK family phosphorylates a number of transcription factors such as runt-related transcription factor-2 (RUNX-2) [24]. Pomegranate extract, with its rich source of polyphenols, can inhibit IL-1 α-induced activation of MKK3, DNA-binding activity of RUNX-2 transcription factor, and p38 α-MAPK isoform [23].

Mélanie Spilmont 2015 [25] study also investigated whether the consumption of pomegranate peel extract could limit the process of osteopenia. They demonstrated that in ovariectomized mice, pomegranate peel extract consumption was able to significantly prevent the decrease in bone mineral density (-31.9%; $p < 0.001$ *vs.* OVX mice) and bone microarchitecture impairment.. Their findings concluded that pomegranate peel extract may be effective in preventing the bone loss associated with ovariectomy in mice, and offers a promising alternative for the nutritional management of this disease.

Guards Memory and Brain Function

Pomegranate supplements taken before and after surgery prevented the postoperative memory dysfunction associated with coronary artery bypass or heart valve surgery [26]. In a latest study [27] subjects with self-reported memory problems were randomly assigned to receive 8 ounces of pomegranate juice of a placebo with similar flavor. Over a four-week study period, the subjects participated in memory tests, MRI scans, and blood draws.Those participants in the pomegranate juice group saw "*significant improvement*" in their verbal memory tests and their plasma antioxidant levels. They even showed increased brain activity during memory and verbal testing, suggesting the juice helped encourage increased blood flow to "critical task-related" regions of the brain. The onset of Alzheimer's disease also can be slowed and some of its symptoms curbed by a natural compound that is found in pomegranate. Also, the painful inflammation that accompanies illnesses such as rheumatoid arthritis and Parkinson's disease could be reduced, according to the findings of a two-year project headed by University of Huddersfield scientist Dr Olumayokun Olajide, who specialises in the anti-inflammatory properties of natural products. Braidy *et al*. [28] also demonstrated that the pomegranate juice extract can ameliorate 1-methyl-4-phenyl-1, 6-tetrahydropyridine (MPTP)-induced neurotoxicity in human primary neurons by

attenuating redox imbalance to a greater extent and slowing down age-related neurodegeneration. Although there are no proven methods to delay the onset or slow down the progression of AD, PD, and ALS, recent studies suggest that dietary interventions can alleviate the risk of neurodegeneration.

Conclusion

Pomegranates have been cherished for their exquisite beauty, flavor, color, and health benefits for centuries .Pomegranate has anti-inflammatory effects that may protect against cancer and other chronic diseases[29]. Many studies have also shown that they have incredible benefits for your body, and may lower the risk of all sorts of diseases [30]. Pomegranate is an ideal fruit for human health.

References

1. Newman R. Sydney, Australia: Readhowyouwant; A wealth of phtochemicals. Pomegranate: The Most Medicinal Fruit (Large Print 16pt) 2011.p.184.
2. Saxena A, Vikram NK. Role of selected Indian plants in management of type 2 diabetes: a review. J ltern Complement Med 2004;10:369-378.
3. Lad V, Frawley D. The Yoga of Herbs. Santa Fe, NM:Lotus Press; 1986:135-136.
4. Naqvi SA, Khan MS, Vohora SB. Antibacterial, antifungal, and antihelminthic investigations on Indian medicinal plants. Fitoterapia 1991;62:221-228.
5. Caceres A, Giron LM, Alvarado SR, Torres MF. Screening of antimicrobial activity of plants popularly used in Guatemala for treatment of dermatomucosal diseases. J Ethnopharmacol 1987;20:223-237.
6. Sedigheh Asgary, Mahtab Keshvari, Amirhossein Sahebkar, Mohamad Hashemi, and Mahmoud Rafieian-Kopaei, Clinical investigation of the acute effects of pomegranate juice on blood pressure and endothelial function in hypertensive individuals, ARYA Atheroscler. 2013 Nov;9(6):326–331.
7. Gil MI, Tomás-Barberán FA, Hess-Pierce B, Holcroft DM, Kader AA. Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing. J Agric Food Chem. 2000 Oct;48(10): 4581-9.
8. Anusree SS, Priyanka A, Nisha VM, Das AA, Raghu KG, An in vitro study reveals the nutraceutical potential of punicic acid relevant to diabetes via enhanced GLUT4 expression and adiponectin secretion. Food Funct. 2014 Oct;5(10):2590-601.
9. Newman RA, Lansky EP, Block ML. Pomegranate: The Most Medicinal Fruit. Laguna Beach, California: Basic Health Publications; A Wealth of Phytochemicals; 2007.p.120.
10. Esmaillzadeh A, Tahbaz F, Gaieni I, Alavi-Majd H, Azadbakht L. Concentrated pomegranate juice improves lipid profiles in diabetic patients with hyperlipidemia. J Med Food 2004;7:305–8.
11. Aviram M., and Dornfeld L.: Pomegranate juice consumption inhibits serum angiotensin converting enzyme activity and reduces systolic blood pressure. Athero 2001;158:195-198.
12. Aviram M, Rosenblat M, Gaitini D, et al: Pomegranate juice consumption for 3 years by patients with carotid artery stenosis reduces common carotid intima-media thickness, blood pressure and LDL oxidation. Clin Nutr 2004;23:423-433.
13. Aviram M, Volkova N, Coleman R, et al: Pomegranate phenolics from the peels, arils, and flowers are antiatherogenic: studies in vivo in atherosclerotic apolipoprotein e-deficient (E 0) mice and in vitro in cultured macrophages and lipoproteins. Journal of Agricultural and Food Chemisry 2008;56:1148-1157.
14. Proteomics. 2012 Nov;12(21):3251-62.
15. J Med Food. 2005 Winter;8(4):469-75
16. Suppression of urinary bladder urothelial carcinoma cell by the ethanol extract of pomegranate fruit through cell cycle arrest and apoptosis. Lee ST, Lu MH, Chien LH, Wu TF, Huang LC, Liao GI - BMC Complement Altern Med - January 1, 2013;13:364.
17. Hora JJ, Maydew ER, Lansky EP, Dwivedi C. Chemopreventive effects of pomegranate seed oil on skin tumor development in CD1 mice. J Med Food. 2003;6:157–61.
18. Syed DN, Malik A, Hadi N, Sarfaraz S, Afaq F, Mukhtar H. Photochemopreventive effect of pomegranate fruit extract on UVA-mediated activation of cellular pathways in normal human epidermal keratinocytes. Photochem Photobiol. 2006;82:398–405.
19. Adams LS, Seeram NP, Aggarwal BB, Takada Y, Sand D, et al. Pomegranate juice, total pomegranate ellagitannins, and punicalagin suppress inflammatory cell signaling in colon cancer cells. J Agric Food Chem. 2006;54:980–985.
20. Khan N, Afaq F, Kweon MH, et al: Oral consumption of pomegranate fruit extract inhibits growth and progression of primary lung tumors in mice. Cancer Res 2007;67:3475-3482.
21. Sartippour MR, Seeram NP, Rao JY, et al: Ellagitannin-rich pomegranate extract inhibits angiogenesis in prostate cancer in vitro and in vivo. Int J Oncol 2008;32:475-48.
22. Balbir-Gurman A, Fuhrman B, Braun-Moscovici Y, Markovits D, Aviram M Consumption of pomegranate decreases serum oxidative stress and

reduces disease activity in patients with active rheumatoid arthritis: a pilot study. Isr Med Assoc J. 2011 Aug;13(8):474-9.

23. Rasheed Z, Akhtar N, Haqqi TM. Pomegranate extract inhibits the interleukin-1b-induced activation of MKK-3, p38a-MAPK and transcription factor RUNX-2 in human osteoarthritis chondrocytes-Arthritis Res Ther. 2010;12:195.
24. Loeser RF, Erickson EA, Long DL. Mitogen-activated protein kinases as therapeutic targets in osteoarthritis. Curr Opin Rheumatol. 2008;20:581–6.
25. Mélanie Spilmont, Laurent Léotoing Marie-Jeanne Davicco, Patrice Lebecque, Elisabeth Miot-Noirault, Paul Pilet, Laurent Rios, Yohann Wittrant and Véronique Coxam Pomegranate Peel Extract Prevents Bone Loss in a Preclinical Model of Osteoporosis and Stimulates Osteoblastic Differentiation in Vitro, Nutrients 2015;7(11):9265-9284.
26. Ropacki SA, Patel SM, Hartman RE. Pomegranate Supplementation Protects against Memory Dysfunction after Heart Surgery: A Pilot Study. Evid Based Complement Alternat Med 2013;2013:93240
27. Opacki SA, Patel SM, Hartman RE. Pomegranate Supplementation Protects against Memory Dysfunction after Heart Surgery: A Pilot Study. Evid Based Complement Alternat Med 2013;2013:93240.
28. Bookheimer SY, Renner BA, Ekstrom A, Li Z, Henning SM, Brown JA, Jones M, Moody T, Small GW. Pomegranate juice augments memory and FMRI activity in middle-aged and older adults with mild memory complaints Evid Based Complement Alternat Med. 2013;2013:946298.
29. Braidy N, Selvaraju S, Essa MM, Vaishnav R, Al-Adawi S, Al-Asmi A, et al. Neuroprotective effects of a variety of Pomegranate Juice extracts against MPTP-induced cytotoxicity and oxidative stress in human primary neurons. Oxid Med Cell Longev 2013;2013:685909.
30. Panchal SK, Ward L, Brown L: Ellagic acid attenuates high-carbohydrate, high-fat diet-induced metabolic syndrome in rats. Eur J Nutr 2012.
31. Gil MI, Tomás-Barberán FA, Hess-Pierce B, Holcroft DM, Kader AA. Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing. J Agric Food Chem. 2000 Oct;48 (10):4581-9.

Revised Rates for 2017 (Institutional)

Title	Frequency	Rate (Rs): India		Rate ($):ROW	
Community and Public Health Nursing	3	5000	4500	357	300
Dermatology International	2	5000	4500	357	300
Gastroenterology International	2	5500	5000	393	340
Indian Journal of Agriculture Business	2	5000	4500	500	450
Indian Journal of Anatomy	4	8000	7500	571	500
Indian Journal of Ancient Medicine and Yoga	4	7500	7000	536	500
Indian Journal of Anesthesia and Analgesia	4	7000	6500	500	450
Indian Journal of Biology	2	5000	4500	357	300
Indian Journal of Cancer Education and Research	2	8500	8000	607	550
Indian Journal of Communicable Diseases	2	8000	7500	571	500
Indian Journal of Dental Education	4	5000	4500	357	300
Indian Journal of Emergency Medicine	2	12000	11500	857	800
Indian Journal of Forensic Medicine and Pathology	4	15500	15000	1107	1050
Indian Journal of Forensic Odontology	2	5000	4500	357	300
Indian Journal of Genetics and Molecular Research	2	6500	6000	464	400
Indian Journal of Hospital Administration	2	6500	6000	464	429
Indian Journal of Hospital Infection	2	12000	9000	857	800
Indian Journal of Law and Human Behavior	2	5500	5000	393	350
Indian Journal of Library and Information Science	3	9000	8500	643	600
Indian Journal of Maternal-Fetal & Neonatal Medicine	2	9000	8500	643	600
Indian Journal of Medical & Health Sciences	2	6500	6000	464	410
Indian Journal of Obstetrics and Gynecology	4	9000	8500	643	600
Indian Journal of Pathology: Research and Practice	4	11500	11000	821	780
Indian Journal of Plant and Soil	2	65000	60000	4623	4100
Indian Journal of Preventive Medicine	2	6500	6000	464	410
Indian Journal of Research in Anthropology	2	12000	11500	857	800
Indian Journal of Surgical Nursing	3	5000	4500	357	300
Indian Journal of Trauma & Emergency Pediatrics	4	9000	8500	643	600
Indian Journal of Waste Management	2	9000	8000	643	579
International Journal of Food, Nutrition & Dietetics	3	5000	4500	357	300
International Journal of Neurology and Neurosurgery	2	10000	9500	714	660
International Journal of Pediatric Nursing	3	5000	4500	357	300
International Journal of Political Science	2	5500	5000	550	500
International Journal of Practical Nursing	3	5000	4500	357	300
International Physiology	2	7000	6500	500	450
Journal of Animal Feed Science and Technology	2	78000	70000	5571	5000
Journal of Cardiovascular Medicine and Surgery	2	9500	9000	679	630
Journal of Forensic Chemistry and Toxicology	2	9000	8500	643	600
Journal of Geriatric Nursing	2	5000	4500	357	300
Journal of Medical Images and Case Reports	2	5000	4500	357	300
Journal of Microbiology and Related Research	2	8000	7500	571	520
Journal of Nurse Midwifery and Maternal Health	3	5000	4500	357	300
Journal of Organ Transplantation	2	25900	25000	1850	1700
Journal of Orthopaedic Education	2	5000	4500	357	300
Journal of Pharmaceutical and Medicinal Chemistry	2	16000	15500	1143	1100
Journal of Practical Biochemistry and Biophysics	2	5500	5000	393	340
Journal of Social Welfare and Management	3	5000	4500	357	300
New Indian Journal of Surgery	4	7500	7000	536	480
New Journal of Psychiatric Nursing	3	5000	4500	357	300
Ophthalmology and Allied Sciences	2	5500	5000	393	340
Otolaryngology International	2	5000	4500	357	300
Pediatric Education and Research	3	7000	6500	500	450
Physiotherapy and Occupational Therapy Journal	4	8500	8000	607	550
Psychiatry and Mental Health	2	7500	7000	536	490
Urology, Nephrology and Andrology International	2	7000	6500	500	450

Terms of Supply:

1. Agency discount 10%. Issues will be sent directly to the end user, otherwise foreign rates will be charged.
2. All back volumes of all journals are available at current rates.
3. All Journals are available free online with print order within the subscription period.
4. All legal disputes subject to Delhi jurisdiction.
5. Cancellations are not accepted orders once processed.
6. Demand draft / cheque should be issued in favour of "Red Flower Publication Pvt. Ltd." payable at Delhi
7. Full pre-payment is required. It can be done through online (http://rfppl.co.in/subscribe.php?mid=7).
8. No claims will be entertained if not reported within 6 months of the publishing date.
9. Orders and payments are to be sent to our office address as given above.
10. Postage & Handling is included in the subscription rates.
11. Subscription period is accepted on calendar year basis (i.e. Jan to Dec). However orders may be placed any time throughout the year.

Order from

Red Flower Publication Pvt. Ltd., 48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi - 110 091 (India), Tel: 91-11-22754205, 45796900, Fax: 91-11-22754205. E-mail: sales@rfppl.co.in, Website: www.rfppl.co.in

Review Article

International Journal of Food, Nutrition and Dietetics
Volume 5 Number 2, May - August 2017
DOI: http://dx.doi.org/10.21088/ijfnd.2322.0775.5217.6

Fat Replacers in Food Production

Urmimala Baruah*, Ruma Bhattacharyya**

Abstract

Dietary factors are implicated in the etiology of a number of chronic degenerative diseases. High fat intake is associated with increased risk for some types of cancer, and saturated fat intake is associated with high blood cholesterol and coronary heart disease. Also, consumption of a diet rich in fat has been identified as a risk factor for excess energy intake, positive energy balance, and the development of obesity. Consequently, health conscious individuals are modifying their dietary habits and eating less fat. Consumer acceptance of any food product depends upon taste—the most important sensory attribute. Although consumers want foods with minimal to no fat or calories, they also want the foods to taste good. Foods formulated with fat replacers are enjoyable alternative to familiar high-fat foods. By choosing these alternative foods, health conscious consumers are able to maintain basic food selection patterns and more easily adhere to low-fat diet.

Keywords: Fat Replacers; Fat Mimetics; Fat Substitutes; Low-Fat.

Introduction

As a food component, fat contributes key sensory and physiological benefits. Fat contributes to flavor, or the combined perception of mouthfeel, taste, and aroma/odor (Lucca, 1994; Mistry, 2001; Sampaio, 2004). Fat also contributes to creaminess, appearance, palatability, texture, and lubricity of foods and increases the feeling of satiety during meals (Romanchik-Cerpovicz, 2002; Sipahioglu, 1999). Fat can also carry lipophilic flavor compounds, act as a precursor for flavor development (e.g., by lipolysis or frying), and stabilize flavor (Romeih, 2002; Tamime, 1999). From a physiological standpoint, fat is a source of fat-soluble vitamins, essential fatty acids, precursors for prostaglandins, and is a carrier for lipophilic drugs (Trudell, 1996, Cooper, 1997, Harrigan, 1989). Fat is the most concentrated source of energy in the diet, providing 9 kcal/g compared to 4 kcal/g for proteins and carbohydrates.

Dietary factors are implicated in the etiology of a number of chronic degenerative diseases (Harrigan, 1989; Haumann, 1986). High fat intake is associated with increased risk for some types of cancer, and saturated fat intake is associated with high blood cholesterol and coronary heart disease (Krauss, 2001; Poppitt, 1995). Also, consumption of a diet rich in fat has been identified as a risk factor for excess energy intake, positive energy balance, and the development of obesity (Thomas, 1992; Wylie-Rosett, 2002; Siggaard,1996).

Overweight and obesity are the fifth leading risk for global deaths. At least 2.8 million adults die each year as a result of being overweight or obese (WHO, May 2012). In 2010, more than 40 million children under five were overweight. Close to 35 million overweight children are living in developing countries and 8 million in developed countries (WHO). In the Indian scenario, even with the growing awareness about health and fitness, more than 3 percent (3 crores) of the Indian population is obese. (Obesity Foindation of India, 2009).

CVDs are the number one cause of death globally: more people die annually from CVDs than from any other cause (WHO, Sept. 2012). An estimated 17.3 million people died from CVDs in 2008, representing 30% of all global deaths. Of these deaths, an estimated

Author's Affiliation: *Asstt. Professor, Dept. of Home Science, Lakhimpur Girls' College, Lakhimpur, Assam. **Professor, Dept. of Food Science & Nutrition, Faculty of Home Science, Assam Agricultural University, Jorhat.

Corresponding Author: Ruma Bhattacharyya, Professor, Dept. of Food Science & Nutrition, Faculty of Home Science, Assam Agricultural University, Jorhat.
E-mail: rumab76@gmail.com

Recieved on 29.04.2017, **Accepted on** 09.05.2017

7.3 million were due to coronary heart disease and 6.2 million were due to stroke (WHO, 2012). In India, about 25 per cent of deaths in the age group of 25- 69 years occur because of heart diseases. The proportion of deaths caused by heart disease is the highest in south India (25 per cent) and lowest - 12 per cent - in the central region (India Today, 2010) .

The Surgeon General's Report on Nutrition and Health states: "High intake of total dietary fat is associated with increased risk for obesity, some types of cancer, and possibly gallbladder disease. Epidemiologic, clinical, and animal studies provide strong and consistent evidence for the relationship between saturated fat intake, high blood cholesterol, and increased risk for coronary heart disease. Excessive saturated fat consumption is the major dietary contributor to total blood cholesterol levels." In addition to the Surgeon General, the National Academy of Sciences, American Heart Association, National Cholesterol Education Program, American Cancer Society, American Dietetic Association, National Institutes of Health, USDA and the Department of Health and Human Services are among the many health and government authorities that advocate reduction of dietary fat for most consumers. Generally, these groups recommend that even healthy consumers would benefit from reducing fat to no more than 30 percent of total calories (Calorie Control Council, 2017).

Considering an average consumption of 34 percent of calories from fat, decreasing intake to 30 percent may not seem a monumental task. However, for many people it is exceedingly difficult. To meet this dietary goal, people need to significantly modify their diets — e.g., choose leaner meats, skin poultry and fish, select low-fat/non-fat dairy products and dressings, and limit fried foods. Of course, consumers' strong desire for high-fat foods makes this difficult. In fact, diet and obesity experts have found that consumers have difficulty maintaining diets once their fat consumption dips below 30 percent of total calories. Nevertheless, millions of consumers are trying to change their "high-fat" ways. A national survey conducted in 2000 by Booth Research Services for the Calorie Control Council revealed 188 million adult Americans (88 percent of the adult U.S. population) consume low- or reduced-fat foods and beverages. Another Council survey shows that two-thirds of adults believe there is a need for food ingredients which can replace the fat in food products. According to *Prepared Foods*, more than 2,000 new low- or reduced-fat products have been introduced since 1997 (Calorie Control Council, 2017). Foods formulated with fat replacers are enjoyable alternative to familiar high-fat foods. By choosing these alternative foods, health conscious consumers are able to maintain basic food selection patterns and more easily adhere to low-fat diet (Calorie Control Council, 1996).

Fat may be replaced in food products by traditional techniques such as substituting water (Chronakis, 1997) or air for fat, using lean meats in frozen entrées (Hsu, 2005), skim milk instead of whole milk (Zalazar, 2002) in frozen desserts (Specter, 1994), and baking instead of frying (Haumann, 1986) for manufacturing or preparing snack foods.Some lipids may be replaced in foods by reformulating with selected ingredients that provide some fat-like attributes (Tarr, 1995; Sipahioglu, 1999). These fat replacers can be lipid, protein or carbohydrate-based (Table 1) and can be used alone or in unique combinations (Akoh, 1998; Costin, 1999; Lucca, 1994; Crehan, 2000; Sandrou, 2000).

The term "fat replacer" is used to describe a wide variety of products that replace some or all of the fat in food. The goal is to change the sensory qualities of a food as little as possible while reducing its fat and calorie content. One example of this is the addition of milk solids to reduced-fat or skim milk; another is the addition of ground turkey or other lean meat to processed meat products such as salami.

Types of Fat Replacers

According to Finley and Leveille (1996), there are three categories of fat replacers: fat mimetics, low-calorie fats, and fat substitutes.

Fat mimetics provide the bulk and mouthfeel of fats but have fewer calories. Typical ingredients used to mimic fat are starch, cellulose, pectin, protein, and dextrins (substances related to sugar). Fat mimetics reduce calories not only because they are less calorically dense than fats, but also because they contain a lot of water, which itself replaces part of the fat. Typically, fat mimetics are used in products that have a lot of fluid in them, such as desserts, spreads, and salad dressings(Finley et al., 1996).

Low-calorie fats are actual fats whose structure ensures that they provide fewer calories to the body. For example, salatrim has very short fatty acids and very long ones. The short ones have fewer calories and the long ones are not well absorbed; the result is that the combination contributes only about five calories per gram. Similarly, caprenin is composed partly of a very long fatty acid called behenic acid, which is poorly absorbed, and partly of medium-length fatty acids that are processed differently by the body than are the longer ones. The result is that

caprenin also contributes only about five calories per gram(Finely et al., 1996).

Fat substitutes are the substances most similar to fats functionally. They are heat stable, which is not true of all fat replacers. These substances generally contribute fewer calories than regular fats (or no calories at all) because of their molecular structure (Finely et al., 1996) and/or because of the way the body handles them. One example of a fat substitute is olestra. Olestra is composed of the sugar sucrose (table sugar) and from six to eight fatty acids. Because of the way in which the fatty acids are attached to the sucrose, humans are unable to digest and absorb olestra; thus, it contributes no calories.

Fat replacers are also classified according to the substances from which they are derived: carbohydrate, protein, or fat. Generally, carbohydrate- and protein-based fat replacers are fat mimetics; fat-based fat replacers are low-calorie fats or fat substitutes. Manufacturers commonly use a combination of several fat replacers in one food (Jones, 1995). They do this because fat has more than one function in food, and a single fat replacer often cannot perform all of fat's functions (Calorie Control Council,1996).

Classification of Fat Repalcers

Type of Fat Replacer	Type of Food Products	Commercial Names
Carbohydrate-Based		
Carrageenan	Ground beef, hot dogs, processed cheeses, low-fat desserts	Carrageenan
Cellulose (also called microcrystalline cellulose)	Salad dressings, mayonnaise, processed cheese, frozen desserts	Avicel
Powdered cellulose	Fried foods, sauces	Solka-Floc, JUST FIBER
Dextrins	Salad dressings, puddings, spreads, dairy desserts, meat products	N-OIL, instant N-OIL, Stadex
Gums	Bakery products, frozen desserts, yogurts, dairy products, sauces, soups, reduced-fat margarines, Jaguar, meats, soups, pie fillings, sauce mixes, salad dressings	RHODIGEL, Rhodigum, Dycol, Jaguar, Uniguar
Pectin	Dressings, spreads, frozen desserts, cakes, cookies, frostings, soups, sauces and gravies	Splendid
Polydextrose	Bakery products, bakery mixes, chewing gum, confections, frostings,salad dressings, frozen dairydesserts and mixes, gelatins, puddings, candies	Litesse, StaLite
Vegetable fibers	Frozen, reduced-fat bakery products	
Z-trim	Still experimental but has been used successfully in brownies, cheese, ground-beef patties	

Source: Napier K.(1997). Fat Replacers. The Cutting Edge of Cutting Calories.

Type of Fat Replacer	Type of Food Products	Commercial Names
Protein-Based		
Isolated soy protein	Ground meats, poultry products, beverages, weight-loss products	Supro, ProPlus, Supro Plus
Microparticulated protein	Frozen desserts, cheese, cheesecake, salad dressings, mayonnaise, cakes, pie crusts, pie fillings, pastries, spreads, yogurt, sour cream, pizza, cream soups, cheese sauces, casseroles	Simplesse, Trailblazer
Modified whey concentrate	Frozen dairy desserts, hard and processed cheeses, sour cream, dips, yogurt, sauces, baked goods	Dairy-Lo
Fat-Based		
caprenin	Chocolate-containing confections; not currently in any foods on the market	Caprenin
Mono- and diglycerides	Cake mixes, cookies, icings, select dairy products	Dur-Em, Dur-Lo
Salatrim	Confections, baked goods, dairy products	Benefat
Sucrose polyester (olestra)	Potato chips and other savory snacks	Olean

Source: Napier K.(1997). Fat Replacers. The Cutting Edge of Cutting Calories.

Carbohydrate-Based Fat Replacers

Carbohydrate-based fat replacers are the most widely used fat-replacing ingredients. They are made primarily from grains, cereals, and other plant products. Some examples are starches, fibers, gums, and celluloses. On food labels they can be identified by such terms as dextrin, maltodextrin, modified food starch, polydextrose, cellulose, and gum. Some carbohydrate-based fat replacers are digestible, which means they contribute calories (up to four per gram). Others are indigestible and do not contribute calories(Calorie Control Council,1996).

The first of these carbohydrate-based fat replacers—cellulose gel— became available in the mid-1960s. Cellulose gel was introduced as a stabilizer, a substance added to a food to help make it resistant to changes in texture. Many of the other carbohydrate-based fat replacers were also initially developed to improve various qualities in food—qualities such as thickness, bulk, and moisture. These substances did not come to be used as calorie reducing agents until nearly 30 years later, in the early 1990s (Kurtzweil,1996). Today's carbohydrate-based fat replacers still play multiple roles in foods. These roles range from improving qualities to reducing fat content in many categories of foods. Carbohydrate-based fat replacers are commonly used to reduce—and sometimes eliminate—"fat calories" in such foods as frozen desserts, puddings, salad dressings, gravies, sauces, baked goods, processed meats, cheeses, sour cream, and yogurt (International Food Information Council Foundation,1995). Carbohydrate-based fat replacers cannot be used to fry foods, however, as they break down at the high temperatures required for frying(International Food Information Council Foundation,1995).

Food manufacturers often replace part or all of the fat in a food with a carbohydrate-based fat replacer bound to water. This is possible because starches, celluloses, dextrins, and maltodextrins can hold at least three times their weight in water; some gums can hold as much as 100 times their weight. Typically, this translates into replacing nine "fat calories" with 0–1.33 "nonfat calories," depending on whether a digestible or nondigestible carbohydrate-based fat replacer is used. Calorie and fat-gram savings can be considerable with this type of fat-replacement system (Napier,1997).

Some of the most popular carbohydrate-based fat replacers include the following (Napier, 1997)

Carrageenan (marketed as carrageenan) is an extract of red seaweed. It gained FDA approved in 1961 for use as an emulsifier (a substance that helps oily and watery ingredients stay mixed), as a stabilizer, and as a thickener. Carrageenan came into popular use as a fat replacer in the early 1990s (Kurtzweil,1996), when manufacturers starting using it to provide some of the gel-like mouth feel of fat in select foods. Typically, carrageenan is used to replace part of the fat in ground beef, in hot dogs, in processed cheeses, and in low-fat desserts. Some consumers complain that the taste of such products is compromised, but others find no fault (*The Wall Street Journal,*1996). Carrageenan has been consumed by humans for hundreds of years, with no adverse effects reported (Napier,1997).

Cellulose (marketed as Avicel) is also known as microcrystalline cellulose. It forms a gel in the presence of water and has been used traditionally in foods as a stabilizer. Cellulose has several properties that make it an excellent fat replacer: It acts like a fat in water; it supplies the mouthfeel of fat; it has the glossy, opaque appearance of fat; and it contributes no calories (Calorie Control Council,1996). Cellulose gel is used widely in salad dressings, in mayonnaise, in processed cheeses, and in frozen desserts (Napier,1997).

Powdered cellulose (marketed as Solka-Floc and JUST FIBER) is an insoluble, nondigestible fiber. It is often used in fried foods and bakery products. Like most carbohydrate-based fat replacers, powdered cellulose binds water tightly. Thus, when powdered cellulose is used in the batter of foods to be fried, the cellulose preferentially binds to water instead of to the oil used in frying. The end result is that less of the oil is absorbed by the food as it is fried. Studies have shown that the use of powdered cellulose in fried foods can result in a 40-percent reduction in fat uptake in fried batter coatings and up to a 20-percent fat reduction in fried cake donuts. Powdered cellulose is also used in reduced-fat sauces—products in which the ability of the cellulose to retain relatively large amounts of water is also critically important (Calorie Control Council, 1996).

Dextrins (marketed as N-OIL, instant N-OIL, and Stadex) are made from the starches extracted from tapioca, corn, potato, and rice. Dextrins are known for their ability to mimic several fat sensations, including mouthcoating, the melting sensation, and the richness of fat. They are also excellent at replacing some of the juiciness lost from meat products when fat is removed. In addition, dextrins can form heat-stable gels, which makes them acceptable for use in some cooked foods. Dextrins are commonly used in salad dressings, in puddings, in spreads, in dairy desserts, and in meat products. Naturally occurring

carbohydrates, they have a long history of safe use (Calorie Control Council, 1996).

Polydextrose (marketed as Litesse and StaLite) is made from citric acid, a sugar alcohol called sorbitol, and a sugar extracted from corn. Because human digestive enzymes cannot totally break down polydextrose, some of it passes through the body unabsorbed. Consequently, it contributes only one calorie per gram. Polydextrose was originally developed as a bulking agent—an ingredient added to puff up the volume of cakes and cookies after sugar was removed from the batter. It was subsequently discovered that polydextrose exhibits the mouthfeel characteristics of higher-fat products; as a result, it is also used today to replace some of the fat in bakery items. Eating too much polydextrose can have a laxative effect in some people, however, so products containing more than 17 grams of polydextrose must be labeled with the warning, "Sensitive individuals may experience a laxative effect from excessive consumption of this product." (Calorie Control Council,1996).Typically, a 40-gram candy bar will contain 8 to 12 grams of polydextrose (*The Wall Street Journal,*1996).

Vegetable fibers (no trade names), because of their ability to absorb relatively large amounts of water and their ability to improve the body and texture of foods, are often used to replace some of the fat in various products. Soy, pea, wheat, and oat fibers are used as fat replacers in some baked goods, in meats and in spreads (Calorie Control Council, 1996).

Gums (marketed as RHODIGEL, Rhodigum, Dycol, Jaguar, and Uniguar) have been added to foods for many years as emulsifiers. Because gums have a creamy mouthfeel, they are excellent fat replacers. Most gums pass through the human body virtually unmetabolized; as a class, they have a long history of safe use. Some of the gum names consumers will find on food labels include gum arabic, guar gum, locust bean gum, xanthan, and modified carbohydrate or vegetable gum. *Guar gum* is commonly used to reduce fat in cakes, donuts, ice creams, sour cream, yogurts, cheese products, sauces, and soups. *Gum arabic* is often used to reduce the fat in bakery products, butter, margarine, toppings, spreads, and frozen desserts. *Locust bean gum* is used as a fat replacer in ice creams, sausages, salami, bologna, cheeses, canned meat and fish, sauces, syrups, soups, and pie fillings. *Modified carbohydrate gum/vegetable gum* is used in baked goods, in frozen desserts, in dry sauce mixes, in pourable/ spoonable sauces, and in salad dressings. And xanthan gum may be found in beverages, in frozen fruit-pie fillings, and in some canned foods (Napier, 1997).

Pectin (marketed as Splendid and under other brand names) is made from citrus peel and table sugar. Pectin forms a gel that can replace up to 100 percent of the fat in select foods. Because pectin forms small particles that mimic fat globules, it has the mouthfeel and melting sensation of fat. Pectin is commonly used as a fat replacer in foods that contain emulsified fats (fats suspended in a watery medium). Such foods include soups, sauces, and gravies; cakes and cookies; dressings and spreads; frozen desserts; and frostings (Calorie Control Council, 1996).

Z-Trim is a recently developed fat replacer. Its availability was announced in late August 1996 by the USDA. Z-trim is made from the processed hulls of oats, soybeans, peas, and rice or from the bran of corn or wheat. The hulls or bran are processed into microscopic fragments, which are then purified, dried, and milled into a powder. Because the fragments absorb water, they swell to provide the smooth mouthfeel of fat. Z-trim also replaces the moistness and density that fat gives to foods. Z-trim passes virtually unmetabolized through the human body, so it contributes no calories. No adverse gastrointestinal side effects have been noted from the consumption of Z-trim containing products (Napier, 1997).

Z-trim has already been added successfully to brownies, to ground beef patties, and to cheeses. Z-trim can cut the fat calories in a brownie from 25 percent to just 15.5 percent of total calories. It can replace up to 15 percent of the fat in ground beef while boosting the meat's tenderness and juiciness. Z-trim was developed by a USDA researcher from GRAS ingredients. Once the patent has been received, the USDA will license the production process to private companies, enabling them to develop commercial products containing Z-trim (USDA,1996).

Protein-Based Fat Replacers

Unlike carbohydrate-based fat replacers—many of which were initially developed to improve such qualities as thickness, bulk, and moisture in foods and which only secondarily came to be used as fat replacers— protein-based fat replacers were designed specifically to replace fat. 4 Protein-based fat replacers are typically made from milk, egg, and whey proteins modified by a process called microparticulation. As the name implies, this process produces tiny particles. In the mouth, the particles act like tiny ball bearings, rolling over one another easily. The end result is a food with the same creamy, slippery texture of its higher-fat counterparts. Protein-based fat replacers

are commonly used in butter, cheese, mayonnaise, salad dressings, frozen dairy desserts, sour cream, and baked goods. These fat substitutes generally give a better mouthfeel than do carbohydrate- based substances; however, like their carbohydrate-based counterparts, protein-based fat replacers cannot be used for frying (FDA, 1995).

Microparticulated protein (marketed under the brand names Simplesse and Trailblazer) is made from microparticulated milk and/or egg-white proteins, sugar, pectin, and citric acid. When added to foods, these products successfully perform many of the functions of fat, and they impart a fatlike creaminess and richness. They are lacking in fat-type flavor, however. Because microparticulated protein fat replacers are not heat-stable, they are used chiefly in cold products such as ice cream, butter, margarine, sour cream, and salad dressings. Microparticulated protein fat replacers provide 1.33 calories per gram, as compared with the nine calories per gram of regular fats. Used in ice cream, a single gram of Simplesse can replace three grams of fat, for a saving of 23 calories (Gershoff, 1995).

Modified whey protein (marketed as Dairy-Lo) is made from high quality whey (or milk) protein concentrate. Modified whey protein does an excellent job of improving the texture, flavor, and stability of low-fat foods. It replaces fat at four calories per gram and is typically used in frozen dairy desserts; in hard and processed cheeses; in sour cream, dips, and yogurts; in sauces; and in baked goods(Calorie Control Council, 1996). Its ability to prevent shrinkage and iciness in frozen foods makes it especially desirable as a fat replacer in those products (Napier, 1997).

Isolated soy protein (marketed as Supro, ProPlus, and Supro Plus) has been used in foods for 35 years. Isolated soy protein is not meant to replace the fat in foods functionally; manufacturers add it simply to reduce the fat content of foods—primarily meat products. Isolated soy protein is also used in some beverages and in weight-loss products. The USDA allows up to two percent isolated soy protein in cooked sausages; it allows higher levels inground meats and poultry products(Calorie Control Council, 1996).

Fat-Based Fat Replacers

Fat-based fat replacers are the newest category of fat replacers. They have the most acceptable taste of any of the fat substitutes and they provide a mouthfeel closest to that of fat. And now, one type of product meets one of the greatest challenges to fat replacers: It is thermally stable enough to be used in frying (Calorie Control Council,1996). Fat-based fat replacers are made from some of the same ingredients found in natural fats. But because these ingredients are formulated in such a way that the body cannot absorb them completely—in some cases, not at all—they contribute either fewer calories than their ordinary counterparts or no calories (Napier, 1997).

Sucrose Polyester, also known as olestra (marketed under the name Olean), is the first calorie-free fat substitute approved by the U.S. Food and Drug Administration. Most dietary fats are triglycerides: As the name indicates, they are composed of a carbohydrate (glycerol) with three fatty acids attached. Instead of having a glycerol at its core, olestra contains a larger sugar molecule (sucrose) and has six to eight instead of the usual three fatty acids (Mayo Clinic Health Letter, 1996). Olestra looks, tastes, and acts like real fat, but its formulation causes it to pass through the body totally unabsorbed, contributing no calories to the diet (Napier, 1997).

In January 1996 the FDA approved the use of olestra in potato chips and other savory snacks. Using olestra instead of real fat to fry these products reduces their calories substantially: A one-ounce serving of potato chips fried in olestra contains no fat and 70 calories; a one-ounce serving of ordinary chips contains 10 grams of fat and 160 calories. Potentially, olestra could be used to replace fat in a wide variety of foods: oils, ice cream, salad dressings, and cheeses. But, as with every food additive, each new use of olestra must be approved by the FDA. To date, the only approved use of olestra is as a replacement for the fat used in the production of some salty snack foods such as potato and tortilla chips, crackers, and cheese curls. Currently, olestra is the only fat replacer approved and on the market that can be used for frying. So far, it has been approved only for commercial uses, but it would also potentially be suitable for home use(Napier, 1997).

Some vocal opponents have questioned olestra's safety, but that safety has been documented in more than 100 animal studies and 98 human studies conducted over the past 20 years (Calorie Control Council, 1996).According to the FDA (1995), these studies included:

- Animal and human studies which showed that olestra does not break down in the digestive tract;
- Animal studies which showed that olestra is not absorbed into the body;
- Animal studies which showed that olestra does not cause birth defects;
- Animal studies which showed that a diet

containing olestra is not associated with a higher incidence of cancer;

- Animal and human studies which showed that olestra's effects on the absorption of the four fat-soluble vitamins (vitamins A, D, E, and K) can be offset by supplementing olestra-containing foods with these vitamins;
- Animal and human studies which showed that olestra does not decrease the absorption of five key water-soluble nutrients (folate, vitamin B12, calcium, zinc, and iron) that are hard to absorb or that are limited in the U.S. diet;
- Human studies which showed that at usual snack-food consumption levels, olestra's potential to cause cramping, bloating, loose stools, diarrhea, and other gastrointestinal symptoms in healthy adults and children and in adults with inflammatory bowel disease is no different than that of the full-fat snack foods olestra-containing products can replace;
- Human studies which showed that olestra does not affect normal intestinal microflora functions; and
- Animal and human studies which showed that olestra does not affect the absorption of some commonly used drugs, especially drugs that attach to fat in the body, such as oral contraceptives.

Two main areas were investigated in these extensive studies. The most significant area of study focused on olestra's ability to decrease the absorption of fat-soluble vitamins (vitamins A, D, E, and K). Because olestra is an oil and passes through the body unabsorbed, it carries a certain amount of these fat-soluble substances with it(Finley et al., 1996). The FDA is satisfied, however, that fortifying olestra-containing foods with fat-soluble vitamins adequately offsets this effect (FDA,1995; Cooper et al., 1997).The rationale is that when these vitamins are dissolved in the olestra before it is eaten, the olestra no longer has "room" to pick up additional fat-soluble vitamins from foods as it passes through the body. Stated yet another way, with fortification there is no net loss of vitamins (Schlagheck et al., 1994).

Another area investigated was the potential impact of olestra on the body's absorption of beta-carotene and other carotenoids from foods eaten at the same time as olestra-containing foods. (The carotenes are a group of yellow-red chemicals found in both plants and animals. Some can be converted to vitamin A in the body; some have antioxidant activity). The consumption of olestra products as part of a meal that also includes carotene- rich items such as carrots can block the absorption of some of the betacarotene (Napier, 1997).

A recent estimate of the magnitude of this effect is that betacarotene absorption would be reduced by 6.0 to 9.5 percent, depending on how much olestra was consumed along with the carotene-containing food(Cooper et al., 1997). It is difficult to evaluate completely the potential health effects of the diminished absorption of carotenoids. Carotenoids are not known to be essential for human diets, but some scientists believe they protect us from cancer and other diseases. The only proven health role for beta-carotene and other carotenoids is as a precursor to vitamin A—and the potential effect of olestra on vitamin A has been addressed by fortification. When advocates argue that substantial ingestion of beta-carotene will decrease cancer risk, they are referring mostly to studies that do not link the intake of betacarotene *per se* with lower cancer risk. Rather, the studies link the high intake of fruits and vegetables—with their vitamins, minerals, carotenoids, and other phytochemicals—with lower cancer risk (Block et al., 1992; Ziegler,1991). Indeed, recent epidemiological studies indicate that beta-carotene is ineffective at protecting people from lung cancer and may even increase the risk of lung cancer in smokers (The Alpha-Tocopherol, Beta Carotene Cancer Prevention Study Group,1994; Rowe,1996).

While recognizing that additional data on the impact of small decreases in carotenoid uptake would be helpful, we must remember that foods often interact with each other to alter the absorption of some nutrients. In a balanced diet any losses that may occur in one meal are generally made up in another. Having a glass of milk can reduce iron absorption from a typical breakfast cereal by 50 percent. A high-fiber meal can reduce the absorption of beta-carotene by 50 percent (Hassal,1994). But neither of these examples of food–nutrient interaction has caused nutritionists to advise against drinking milk or eating fiber. This is because both instances cited involve only one meal, not an overall diet. At a single meal olestra can lower carotenoid absorption just as fiber can. This decrease depends on the carotenoids and the olestra-containing foods' being eaten at the same time, however. For people eating olestra-containing savory snack foods, the effect on carotenoid absorption is less than 6 percent—well within the variability seen in people eating a normal mixed diet. Conceivably, olestra could be fortified with carotenoids; but at this time the FDA—basing its decision on input from the National Cancer Institute and the National Eye Institute—has recommended that, since there is no

basis on which to do so, carotenes should not be added to olestra in snack foods (U.S. Department of Health and Human Services, Food and Drug Administration, 1996).

Some people experience loose stools after consuming olestra-containing foods. Because of this the FDA requires manufacturers of olestra-containing foods to include a label statement telling consumers about this potential side effect (*FDA Consumer,* 1996).

And olestra appears to offer a benefit: It can inhibit cholesterol absorption and lower blood cholesterol levels (Finley et al., 1996). In one study 20 men with normal cholesterol levels were fed 750 milligrams (mg) of cholesterol per day along with either butter or a butter-olestra blend. The group receiving the olestra absorbed about 18 percent less cholesterol than the group receiving all butter (Jandacek et al., 1990).In another study 24 healthy, normal-weight men with normal cholesterol levels were fed 300 or 800 mg of cholesterol in a typical American diet (a diet containing 20 percent of its calories as protein, 40 percent as fat and 40 percent as carbohydrate). Adding olestra to the diet lowered both total and LDL-("bad") cholesterol(Crouse et al.,1979). The same authors later studied the effect of this type of dietary regimen on obese people: Again, they found that the subjects' total and LDL-cholesterol levels both fell (Beaton et al., 1992).

Salatrim (marketed as Benefat) is the name for a family of reduced-calorie fats typically made from soybean or canola oil. (The name "salatrim" stands for *s*hort *a*nd *l*ong chain *a*cid *tri*glyceride *m*olecules.) Salatrim provides just five calories per gram, rather than the typical nine of regular fats. Salatrim can be used to reduce the fat in a variety of products such as baked goods, confections and dairy products. Unlike olestra, salatrim cannot be used for frying (Calorie Control Council.,1996).

Caprenin, like salatrim, provides only about five calories per gram. It is a good substitute for cocoa butter and can be used in confections.16 Caprenin cannot be used for frying foods, and it is not in any foods currently on the market.

Mono- and diglycerides (marketed as Dur-Em, Dur-Lo, etc.) were developed as emulsifiers—ingredients that help disperse fat in watery mediums. Mono- and diglycerides help stretch fats or spread them more widely throughout a food, thereby allowing less fat to be used in the product. So, although mono- and diglycerides have the same caloric value as other fats— nine calories per gram—their use can result in a substantial fat and calorie reduction. Mono- and diglycerides are used to replace all or part of the shortening in cake mixes, in cookies, in icings, and in select dairy products(Calorie Control Council.,1996).

Conclusion

Fat replacers have a tremendous potential to decrease the fat content as well as the overall calorie content of the diet. Fat replacers can help consumers avoid both the physical and the psychological feelings of deprivation that may arise when they attempt to follow strict, low-fat eating plans—feelings of deprivation that can cause dieters to revert to the higher fat eating styles that keep them from achieving healthier body weights (Napier,1997).There is no "magic bullet" to achieving dietary goals. A prudent approach, however, is combining proper nutrition, dietary variety, with a healthy lifestyle, regular exercise, and a reduction of total dietary fat aided by choosing foods formulated with fat replacers (Akoh,1998).

References

1. Akoh, C.C. Synthesis of carbohydrate fatty acid polyesters. In "Carbohydrate Polyesters as Fat Substitutes," ed. 1994.p.9-35.
2. Akoh, C.C. Fat replacers. Food Technology. 1998;52:47-52.
3. Babayan, V.K. (Specialty lipids and their biofunctionality. Lipids. 1987;22:417-420.
4. Bastin S. Fat Replacers. *T*he National Academy of Science's Diet and Health Report, Healthy People 2000: National Health Promotion and Disease Objectives and the Dietary Guidelines for Americans issued jointly by the U.S. Department of Agriculture and the U.S. Health and Human Services. 2000.
5. Beaton GH, Tarasuk V, Anderson GH. (1992). Estimation of possible impact of non-caloric fat and carbohydrate substitutes on macronutrient intake in the human. Appetite. 1992;19:87–103.
6. Cáceres, E., et al. The effect of fructooligosac-charides on the sensory characteristics of cooked sausages, Meat Science, 2004;68:87-96.
7. CCC. "Fat Reduction in Foods," Calorie Control Council, Atlanta, Ga. 1996.p.111.
8. Calorie Control Council. Light Products Survey by Booth Research Services Inc., Atlanta, March, 1996.
9. Calorie Control Council. Fat reduction in foods. Atlanta, January 1996.
10. Calorie Control Council. Fat reduction in foods. Atlanta, August, 1996.

11. Calorie Control Council. Fat Replacers. 2017.
12. Cengiz, E., Gokoglu, N. Changes in energy and cholesterol content of frankfurter-type sausages with fat reduction and fat replacer addition, Food Chemistry, 2005;91:443-447.
13. Chronakis, I.S. Structural-Functional and Water-holding Studies of Biopolymers in Low Fat Content Spreads, Lebensmittel-Wissenschaft und-Technologie, 1997;30:36-44.
14. Cooper, D.A., Webb, D.R., Peters, J.C. Evaluation of the potential for Olestra To Affect the Availability of Dietary Phytochemicals, J.Nutr. 1997;127:1699S-1709S.
15. Cooper, D.A., Berry, D.A., Jones, M.B., Kiorpes, A.L. Olestra's Effect on the Status of Vitamins A, D and E in the Pig Can Be Offset by Increasing Dietary Levels of These Vitamins, Journal of Nutrition, 1997;127:1589S-1608S.
16. Costin, G.M., Segal, R. Alimente funcþionale, Ed. Academica, Galaþi. 1999;188-202.
17. Crehan, C.M., et al. Effects of fat level and maltodextrin on the functional properties of frankfurters formulated with 5, 12, and 30% fat, Meat Sci. 2000;55:463-469.
18. Sharma D.C. India's no.1 killer: Heart disease. India Today. 2010 April 12.
19. Duflot, P. Starches and Sugars Glucose polymers as sugar/fat substitutes, Trends in Food Science & Technology, 1996;7:206.
20. Finley JW, Leveille GA. Macronutrient substitutes. In: EE Ziegler and LJ Filer, Jr., eds. Present Knowledge in Nutrition. 7th ed. Washington, DC: ILSI Press. 1996;581–595.
21. Gershoff SN. Nutrition evaluation of dietary fat substitutes. Nutrition Reviews. 1995;53:304–313.
22. Harrigan, K.A., Breene, W.M. Fat substitutes: Sucrose esters and simplesse, Cereal Foods World, 1989;34:261-267.
23. Haumann, B.F. Getting the fat out – researchers seek substitutes for full-fat fat, Journal of American Oil Chemistry Society, 1986;63:278-286.
24. International Food Information Council Foundation. Uses and nutritional Impact of fat reduction ingredients. IFIC Review, Washington, DC, November. 1995.
25. Jandacek, R.J., Ramirez, M.M., and Crouse, J.R. Effects of partial replacement of dietary fat by olestra on dietary cholesterol absorption in man. Metabolism. 1990;39:848-852.
26. Jones SA. Fat replacers: the broad perspective. The World of Ingredients. 1995 September;8–15.
27. Kennedy, J.P. Structured lipids: Fats of the future. Food Technol. 1991;45(11):76, 78, 80, 83.
28. Krauss, R.M., Eckel, R.H., Howard, B., et al. American Heart Association's (AHA): AHA Dietary Guidelines – Revision 2000: A statement for Healthcare Professionals From the Nutrition Committee of the American Heart Association, Journal of Nutrition, 2001;131:132-146.
29. Kurtzweil P. Taking the fat out of food. FDA Consumer. July–August (Internet edition: http://www.fda.gov). 1996.
30. Lucca, P.A., Tepper, B.J. Fat replacer and the functionality of fat in foods, Trends in Food Science and Technology, 1994;5:12-19.
31. Mayo Clinic Health Letter. Fat Substitutes. 1996;14(6):6.
32. Miller, G.D. and Groziak, S.M. Impact of fat substitutes on fat intake. Lipids 1996;31(S):293-296.
33. Mistry, V.V. Low fat cheese technology, Int.Dairy J. 2001;11:413-422.
34. Murray B.C., et.al. Starch Manufacturing-A Profile.Research Triangle Institute. 1994.
35. Napier Kristine. Fat Replacers.The Cutting Edge Of Cutting Calories. American Council On Science And Health. 1997.
36. Obesity Foundation India. Need for awareness in India. 2009.
37. Ognean C.F., et al. Fat Replacers – Review. Journal of Agroalimentary Processes and Technologies, 2006;12(2):433-442.
38. Hill, J., et al. Effects of a 14 d of covert substitution of olestra for conventional fat on spontaneous food intake, Am. J. Clin. Nutr. 1998;67:1178–1185.
39. Peters, J.C., Lawson, K.D., et al. Assessment of the Nutritional Effects of Olestra, a Nonabsorbed Fat Replacement: Introduction and Overview, Journal of Nutrition, 1997;127:1539S-1546S.
40. Poppitt, S.D. Energy density of diets and obesity, International Journal of Obesity, 1995;19:S20-S26.
41. Romanchik-Cerpovicz, J.E., et al. Moisture Retention and Consumer Acceptability of Chocolate Bar Cookies Prepared With Okra Gum as a Fat Ingredient Substitute, Journal of the American Dietetic Association, 2002;102:1301-1303.
42. Romeih, E.A., et al. Low-fat white-brined cheese made from bovine milk and two commercial fat mimetics: chemical, physical and sensory attributes, International Dairy Journal, 2002;12:525-540.
43. Sampaio, G.R., et al. Effect of fat replacers on the nutritive value and acceptability of beef frankfurters, J. Food Composition and Analysis, 2004;18:469-474.
44. Sandrou, D.K., Arvanitoyannis, I.S. Low-Fat/Calorie Foods: Curent State and Perspective, Critical Reviews in Food Science and Nutrition, 2000;40:427-447.
45. Siggaard, R., Raben, A., Astrup, A. Weight loss during 12 weeks' ad libitum carbohydrate-rich diet in

overweight and normal-weight subjects at a Danish work site, Obesity Research, 1996;4:347-356.

46. Sipahioglu, O., Alvarez, V.B., Solano-Lopez, C. Structure, physico-chemical and sensory properties of feta cheese made with tapioca starch and lecithin as fat mimetics, International Dairy Journal, 1999;9: 783-789.
47. Tamime, A.Y., et al. Processed Cheese Analogues Incorporating Fat-Substitutes 2. Rheology, Sensory Perception of Texture and Microstructure, Lebensmittel-Wissenschsft und Techologie, 1999;32:50-59.
48. Tarr, B.D., Bixby, S.H. Proteinaceous grain-based fat substitute Trends in Food Science & Technology, 1995;6:317-318.
49. B. Thomas, C.D., Peters, J.C., Reed, et al. Nutrient balance and energy expenditure during ad libitum feeding of high-fat and high-carbohydrate diets in humans, American Journal of Clinical Nutrition, 1996 Jul 31;55:934-942.
50. Trudell, M.S., Flansburgh, K.A., Gee, D.L. Carbohydrate-Based Fat Substitute is an Acceptable Replacement for margarine in Pumpkin Bar Recipe, Journal of the American Dietetic Association, 1996;96: A43-A44.
51. USDHHS. "The Surgeon General's Report on Nutrition and Health. Publ. No. 88-50210. U.S. Govt. Print. Office, Washington, D.C. 1988.
52. USDA and USDHHS. Nutrition and your health: Dietary guidelines for Americans. 4th ed., Home and Garden Bulletin, No. 232., U.S. Dept. Agriculture and U.S. Dept. Health and Human Services, Washington, D.C. 1995.
53. Unilever NV. Preparation of polyol fatty acid polyesters. Netherlands Patent 1998;8:601,904.
54. Wylie-Rosett, Judith. Fat Substitutes and Health – An Advisory From Nutrition Committee of the American Hearth Association, Circulation, 2002;105:2800-2804.
55. Zalazar, C.A., et al. Effect of moisture level and fat replacer on physicochemical, rheological and sensory properties of low fat soft cheeses, International Dairy Journal, 2002;12i:45-50.

Guidelines for Authors

Manuscripts must be prepared in accordance with "Uniform requirements for Manuscripts submitted to Biomedical Journal" developed by international committee of medical Journal Editors.

Types of Manuscripts and Limits

Original articles: Up to 3000 words excluding references and abstract and up to 10 references.

Review articles: Up to 2500 words excluding references and abstract and up to 10 references.

Case reports: Up to 1000 words excluding references and abstract and up to 10 references.

Online Submission of the Manuscripts

Articles can also be submitted online from http://rfppl.co.in/customer_index.php.

I) First Page File: Prepare the title page, covering letter, acknowledgement, etc. using a word processor program. All information which can reveal your identity should be here. use text/rtf/doc/PDF files. Do not zip the files.

2) Article file: The main text of the article, beginning from Abstract till References (including tables) should be in this file. Do not include any information (such as acknowledgement, your name in page headers, etc.) in this file. Use text/rtf/doc/PDF files. Do not zip the files. Limit the file size to 400 Kb. Do not incorporate images in the file. If file size is large, graphs can be submitted as images separately without incorporating them in the article file to reduce the size of the file.

3) Images: Submit good quality color images. Each image should be less than 100 Kb in size. Size of the image can be reduced by decreasing the actual height and width of the images (keep up to 400 pixels or 3 inches). All image formats (jpeg, tiff, gif, bmp, png, eps etc.) are acceptable; jpeg is most suitable.

Legends: Legends for the figures/images should be included at the end of the article file.

If the manuscript is submitted online, the contributors' form and copyright transfer form has to be submitted in original with the signatures of all the contributors within two weeks from submission. Hard copies of the images (3 sets), for articles submitted online, should be sent to the journal office at the time of submission of a revised manuscript. Editorial office: Red Flower Publication Pvt. Ltd., 48/ 41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi – 110 091, India, Phone: 91-11-22754205, 45796900, 22756995. E-mail: author@rfppl.co.in. Submission page: http://rfppl.co.in/article_submission_system.php?mid=5.

Preparation of the Manuscript

The text of observational and experimental articles should be divided into sections with the headings: Introduction, Methods, Results, Discussion, References, Tables, Figures, Figure legends, and Acknowledgment. Do not make subheadings in these sections.

Title Page

The title page should carry

1) Type of manuscript (e.g. Original article, Review article, Case Report)
2) The title of the article, should be concise and informative;
3) Running title or short title not more than 50 characters;
4) The name by which each contributor is known (Last name, First name and initials of middle name), with his or her highest academic degree(s) and institutional affiliation;
5) The name of the department(s) and institution(s) to which the work should be attributed;
6) The name, address, phone numbers, facsimile numbers and e-mail address of the contributor responsible for correspondence about the manuscript; should be mentoined.
7) The total number of pages, total number of photographs and word counts separately for abstract and for the text (excluding the references and abstract);
8) Source(s) of support in the form of grants, equipment, drugs, or all of these;
9) Acknowledgement, if any; and
l0) If the manuscript was presented as part at a meeting, the organization, place, and exact date on which it was read.

Abstract Page

The second page should carry the full title of the manuscript and an abstract (of no more than 150 words for case reports, brief reports and 250 words for original articles). The abstract should be structured and state the Context (Background), Aims, Settings and Design, Methods and Materials, Statistical analysis used, Results and Conclusions. Below the abstract should provide 3 to 10 keywords.

Introduction

State the background of the study and purpose of the study and summarize the rationale for the study or observation.

Methods

The methods section should include only information that was available at the time the plan or protocol for the study was written such as study approach, design, type of sample, sample size, sampling technique, setting of the study, description of data collection tools and methods; all information obtained during the conduct of the study belongs in the Results section.

Reports of randomized clinical trials should be based on the CONSORT Statement (http://www.consort-statement. org). When reporting experiments on human subjects, indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000 (available at http://www.wma.net/e/policy/l 7-c_e.html).

Results

Present your results in logical sequence in the text, tables, and illustrations, giving the main or most important findings first. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize only important observations. Extra or supplementary materials and technical details can be placed in an appendix where it will be accessible but will not interrupt the flow of the text; alternatively, it can be published only in the electronic version of the journal.

Discussion

Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, What this study adds to the available evidence, effects on patient care and health policy, possible mechanisms)? Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

References

List references in alphabetical order. Each listed reference should be cited in text (not in alphabetic order), and each text citation should be listed in the References section. Identify references in text, tables, and legends by Arabic numerals in square bracket (e.g. [10]). Please refer to ICMJE Guidelines (http://www.nlm.nih.gov/bsd/uniform_requirements.html) for more examples.

Standard journal article

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347-55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3-9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792-801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O, Kidd EAM,

editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 7-27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

More information about other reference types is available at www.nlm.nih.gov/bsd/uniform_requirements.html, but observes some minor deviations (no full stop after journal title, no issue or date after volume, etc).

Tables

Tables should be self-explanatory and should not duplicate textual material.

Tables with more than 10 columns and 25 rows are not acceptable.

Table numbers should be in Arabic numerals, consecutively in the order of their first citation in the text and supply a brief title for each.

Explain in footnotes all non-standard abbreviations that are used in each table.

For footnotes use the following symbols, in this sequence: *, ¶, †, ‡‡,

Illustrations (Figures)

Graphics files are welcome if supplied as Tiff, EPS, or PowerPoint files of minimum 1200x1600 pixel size. The minimum line weight for line art is 0.5 point for optimal printing.

When possible, please place symbol legends below the figure instead of to the side.

Original color figures can be printed in color at the editor's and publisher's discretion provided the author agrees to pay.

Type or print out legends (maximum 40 words, excluding the credit line) for illustrations using double spacing, with Arabic numerals corresponding to the illustrations.

Sending a revised manuscript

While submitting a revised manuscript, contributors are requested to include, along with single copy of the final revised manuscript, a photocopy of the revised manuscript with the changes underlined in red and copy of the comments with the point to point clarification to each comment. The manuscript number should be written on each of these documents. If the manuscript is submitted online, the contributors' form and copyright transfer form has to be submitted in original with the signatures of all the contributors within two weeks of submission. Hard copies of images should be sent to the office of the journal. There is no need to send printed manuscript for articles submitted online.

Reprints

Journal provides no free printed reprints, however a author copy is sent to the main author and additional copies are available on payment (ask to the journal office).

Copyrights

The whole of the literary matter in the journal is copyright and cannot be reproduced without the written permission.

Declaration

A declaration should be submitted stating that the manuscript represents valid work and that neither this manuscript nor one with substantially similar content under the present authorship has been published or is being considered for publication elsewhere and the authorship of this article will not be contested by any one whose name (s) is/are not listed here, and that the order of authorship as placed in the manuscript is final and accepted by the co-authors. Declarations should be signed by all the authors in the order in which they are mentioned in the original manuscript. Matters appearing in the Journal are covered by copyright but no objection will be made to their reproduction provided permission is obtained from the Editor prior to publication and due acknowledgment of the source is made.

but no objection will be made to their reproduction provided permission is obtained from the Editor prior to publication and due acknowledgment of the source is made.

Abbreviations

Standard abbreviations should be used and be spelt out when first used in the text. Abbreviations should not be used in the title or abstract.

Checklist

- Manuscript Title
- Covering letter: Signed by all contributors
- Previous publication/ presentations mentioned, Source of funding mentioned
- Conflicts of interest disclosed

Authors

- Middle name initials provided.
- Author for correspondence, with e-mail address provided.
- Number of contributors restricted as per the instructions.
- Identity not revealed in paper except title page (e.g. name of the institute in Methods, citing previous study as 'our study')

Presentation and Format

- Double spacing
- Margins 2.5 cm from all four sides
- Title page contains all the desired information. Running title provided (not more than 50 characters)
- Abstract page contains the full title of the manuscript
- Abstract provided: Structured abstract provided for an original article.
- Key words provided (three or more)
- Introduction of 75-100 words
- Headings in title case (not ALL CAPITALS). References cited in square brackets
- References according to the journal's instructions

Language and grammar

- Uniformly American English
- Abbreviations spelt out in full for the first time. Numerals from 1 to l0 spelt out
- Numerals at the beginning of the sentence spelt out

Tables and figures

- No repetition of data in tables and graphs and in text.
- Actual numbers from which graphs drawn, provided.
- Figures necessary and of good quality (color)
- Table and figure numbers in Arabic letters (not Roman).
- Labels pasted on back of the photographs (no names written)
- Figure legends provided (not more than 40 words)
- Patients' privacy maintained, (if not permission taken)
- Credit note for borrowed figures/tables provided
- Manuscript provided on a CDROM (with double spacing)

Submitting the Manuscript

- Is the journal editor's contact information current?
- Is the cover letter included with the manuscript? Does the letter:

1. Include the author's postal address, e-mail address, telephone number, and fax number for future correspondence?
2. State that the manuscript is original, not previously published, and not under concurrent consideration elsewhere?
3. Inform the journal editor of the existence of any similar published manuscripts written by the author?
4. Mention any supplemental material you are submitting for the online version of your article. Contributors' Form (to be modified as applicable and one signed copy attached with the manuscript)