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Type of Fats and Oils used, Physical Activity Levels, Dietary Habit and Lipid Profile of Coronary Artery Subjects

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Abstract

Dietary fats comprise of saturated and unsaturated fats. High consumption of saturated fats is implicated in coronary artery diseases. With this background the current research work was envisaged with an intention of knowing the type of fats and oils consumed by CAD subjects, as dietary fats and oils are the vehicle for saturated and unsaturated fatty acids in our diet. The polyunsaturated fatty acids especially omega 3 has shown cholesterol lowering action therefore encouraged to be consumed by CAD subjects. This study was conducted to identity the consumption pattern of fats and oils rich in omega 3 fatty acids. The results show that the majority of cardiac subjects neither consumed or were aware of nutritional benefits of omega fatty acids. Lipid profile was collected to know the lipid profile of the subjects and it showed that majority of subjects were dyslipidemic.

Keywords: CAD; Fats; Oils; Omega-3; Omega-6.

INTRODUCTION

Cardiovascular disease (CVD) is a cluster of diseases including atherosclerosis, hypertension, ischemic heart disease, peripheral vascular disease, heart failure (HF) and injuries that affect the cardiovascular system (the heart and blood vessels). These diseases are interrelated and often coexist. Coronary heart disease (CHD), also called coronary artery disease (CAD) and atherosclerotic heart disease, is the end result of the accumulation of atheromatous plaques within the walls of the arteries that supply the myocardium (the muscle of the heart). Coronary artery disease (CAD) accounts for approximately 610,000 deaths annually (estimated 1 in 4 deaths) and is the leading cause of mortality in the United States. It is the third leading cause of mortality worldwide and is associated with 17.8 million deaths annually.[1]

As India is undergoing an epidemiologic transition *i.e.*, the burden of communicable diseases is on a decline whereas there is considerable

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increase in non-communicable diseases (NCD). In the past 40 years India has seen a 4 fold rise in CHD prevalence and it was reported by Global Burden of Diseases Study that 5.6 million in men and 4.5 million in women disability adjusted life years due to CHD in 1990, whereas it was projected to be 14.4 million and 7.7 million in men and women respectively by 2020.[2]

High blood pressure, high blood cholesterol, smoking, obesity, diabetes, physical inactivity[3] and inflammation[4] are major risk factors. Another key risk factor often overlooked is nutrition, like poor dietary choice *i.e.*, increased consumption of highly processed carbohydrates, high consumption of saturated fat and red meat have a direct effect on fat concentrations in the body (increasing the risk of high LDL cholesterol and obesity). A skewed ratio between omega 3 and omega 6 ratio in the diet is another leading cause for CAD.[5] Studies on the quantity and quality of cooking oil and omega 3 fatty acids consumed by population are, therefore, needed to understand their association and role in CAD occurrence, prevalence and progression.

In this paper, we report on the usage of different types of fats and oils consumed by CAD patients along with physical activity levels and eating habits.

MATERIAL & METHODS

The investigation is a prospective clinical study conducted in Mysuru, a major city in the state of Karnataka. The study was carried out with an interest to collect data on the type of fats and oils by cardiac subjects. The study was carried out at the cardiology department of Sri Jayadeva Institute of cardiovascular sciences and research Hospital, Mysuru. The sample size was n=50, comprising of 28 male and 22 female patients, aged between 20 to 60 years.

All the selected participants were screened for nutritional status, dietary patterns and clinical and biochemical features. And other relevant demographic information was also obtained.

Inclusion Criteria

Patients with coronary artery disease along with the co morbid factors such as diabetes, thyroid problem and hypertension who underwent either procedure or bypass graft.

Exclusion criteria

Patients with communicable diseases were excluded.

Informed consent

A written informed consent was obtained from the subjects before the commencement of the study.

Tools used to conduct the study

A self-reporting questionnaire was developed that captured demographic profile, anthropometric measurements viz., height and weight, physical activity levels, dietary pattern, fat/oils consumed. Medical history and biochemical parameters were secondary data and obtained from the subject's hospital files.

Compilation and Statistical Analysis

The data so obtained was tabulated and subjected to suitable statistical analysis like descriptive analysis to describe the characteristics of the population and clinical parameters studied.

RESULT & DISCUSSION

Demographic Profile

Demographic profile comprises information on, gender, race and ethnicity, socioeconomic background, and age. These factors determine the type and quantity of oil consumed for e.g., in northern, north eastern region people mostly use mustard oil whereas southern part of the country people prefer coconut, peanut and sunflower oil. Table 1 shows the gender and age category of the patients. Age and gender play a role in determining CVD risk factors. Incidence of CVD is more in men compared to women.[6] The dietary pattern showed that 86% were vegetarians and research has shown that plant based diet is beneficial in preventing cardiovascular diseases and rest 16% were non-vegetarian. High consumption of red meat is a risk factor for CVD's as it is high in saturated fats. 84% of the patients were Hindu's and 16% were Muslims. Most of the patients were from urban area 58% and the rest 42% were from semiurban area. The geographical area that a populationlives in, determines ones eating habit and food choices though this has become less significant due to globalization.

Table 1: Gender and age profile of the CAD subjects

Gender (n=50)	Number
Male (28)	
Young adults (17-30)	01
Middle aged adults (31-45)	06
Old - aged adults (above 45)	21
Female (22)	
Young adults (17-30)	Nil
Middle aged adults (31-45)	08
Old - aged adults (above 45)	14

Anthropometric and physical activity

BMI index relates indirectly to fat mass which is a risk factor for various lifestyle associated diseases like obesity, diabetes and CVD. Having higher BMI *i.e.*, <23 is associated with an increased risk of cardiovascular disease (CVD) and physical activity is a vital determinant of BMI and regular physical activity reduces the risk associated with overweight and obesity like metabolic syndrome. The Rotterdam Study a prospective cohort study, conducted in 5344 participants aged 55 years or older concluded that participants with high BMI and low physical activity had a higher risk of CVD than participants with normal weight and high physical activity.[7] From table 2 it can be observed that 46% of male and 23% of female subjects fell under the category of pre-obese. No male subject was obese however 13% of female subjects were obese.

Table 2: BMI of CAD subjects

BMI Category	Male (%)	Female (%)
Underweight (<18.5)	7	9
Normal (18.5-22.9)	36	23
Overweight (23-24.9)	11	32
Pre-obese (25-29.9)	46	23
Obese (30-39.9)	-	13

Lipid profile of the subjects

Lipids are energy dense macronutrients that have vital role in biological system like being part of cell membrane and lipid panel test in serum is done to ascertain the quantity and type of lipid in blood which is correlated to heart health. Lipid molecules like triglyceride, low density lipoprotein, high density lipoproteins, cholesterol are the molecules that are tested among which high triglyceride and low density lipoproteins are a major risk factor for CAD.

Fig. 1 depicts the lipid profile of the subjects studied. LDL levels were high in 29% of the male subjects compared to 27% of female subjects, similarly 29% of male subjects had higher TG levels compared to female subjects (18%). High LDL and TG levels are a strong indicator of CAD.

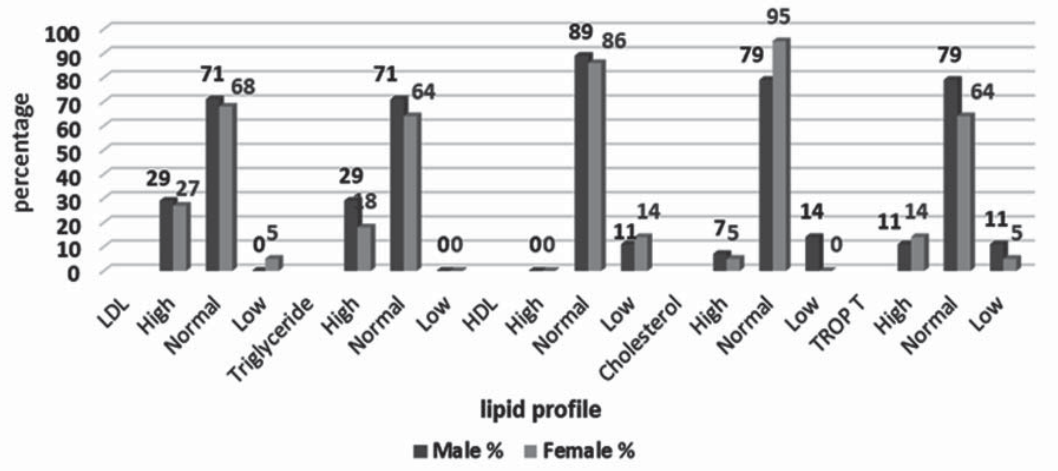

Fig. 1: Lipid profile of the subjects

Hight triglyceride is a strong indicator of CAD, lipids present in food are in the form of TG and it is also the form in which it is stored in human system. TG are made of three fatty acids attached to one glycerol molecule and the fatty acids can be saturated or unsaturated depending on the presence or absence of double bonds. 29% of the male subjects and 18% of the female subjects had high TG levels with rest having normal TG levels which could be attributed to the medications. HDL or high density lipoproteins which is considered good cholesterol as it helps in excretion of fats from the body was normal in 89% of male and 86% of female subjects.

Cholesterol was normal in 79 and 95% of the male and female patients respectively. Cholesterol is synthesized in the human body and is present in animal source food. It is an important component of cellular membrane, hormones and is vital for many biological functions.

There are certain limitations to the standard biochemical markers of cardiac damage due to acute coronary events in terms of sensitivity therefore a constant need for search of more accurate markers.[8] Troponins are a type of proteins found in heart muscles and troponin T (cTnT) and troponin I (cTnI) help regulate calcium mediated interaction between actin and myosin.[9]

These proteins are released upon heart muscle damage andmore sensitive and specific. They are considered superior indicators of myocardial necrosis compared to creatine kinase MB (CK-MB).[10] 11% and 14% of the male and female CAD patients had high levels of TROP T respectively.

Lifestyle factors

Red meat based diet is a major risk factor for CVD compared to a balanced plant based diets. 86% of both male and female CAD patients were non-vegetarian (Table 3).

Table 3: Life style factors of the subjects

Lifestyle Factoes		Male (%) (n=28)	Female (n=22)
Diet	Vegetarian	14.2	13.6
	Non-vegetarian	85.7	86.4
Smoking		75	9.1
Alcohol		17.8	4.5
Physical Activity (walking)		67.8	54.5

Cox proportional hazard model was used to study the relationship between a plant based diet and risk of cardiovascular disease in 123 330 postmenopausal women initially free of CVD in the Women's Health Initiative from 1993 through 2017. The study showed that higher adherence to the Portfolio Diet *i.e.*, combinations of cholesterol-lowering foods in one diet was associated reduced incident of cardiovascular and coronary events, as well as heart failure.[11] Smoking and alcohol are major risk factors for CAD. It was observed from the data collected on smoking and alcohol consumption that more men smoked and had alcohol compared to women patients. 75% male subjects smoked compared to 9.1% female subjects and 17.5% male subjects consumed alcohol in comparison to 4.5% female subject (Table 3). A population based cohort study was conducted in China among 66,743 Chinese men aged 30–89 in Shanghai, recruited from 1996 to 2000 to study the joint effect of cigarette smoking and alcohol consumption on mortality showed that heavy drinkers and smokers had the highest mortality.[12] From the data collected it was observed that male (67.8%) was involved in physical activity compared to 54.5% of females. Physical activity levels are one of the deciding factors of an individual's (BMI) as well. A study conducted in 55 adults to investigate the impact of physical activity (PA) on adiposity and forcardiovascular and metabolic disease risk markers (CMDRMs) showed that body composition and PA intensity play an independent yet an integrated role in CMDRMs. The study further showed that vigorous activity improved blood lipids profile such as high density lipoproteins (HDL), low density lipoproteins (LDL), and arachidonic Acid (ARA)/eicosapentaenoic acid (EPA) ratio and that participants with low PA levels were more likely to have higher levels of leptin and high sensitivity C-reactive protein (hs-CRP).[13]

Dietary fats and Oils Preference

Dietary fats and oils are made of triglycerides comprising of a glycerol molecule attached to 3 fatty acids. The fatty acids can be saturated or unsaturated. Polyunsaturated fatty acids especially omega-3 fatty acids have preventive as well as used in management of CAD.

Milk and milk products, red meat, coconut oil, palm oil, processed foods like ice cream, chocolate, margarine or sandwich spreads, nuts etc., are some sources of saturated fat in the human diet. Saturated fatty acids (SFA) are a strong risk factor for CVD as they increase low density lipoprotein (LDL) cholesterol which leads to plaque formation.[14]

Fig. 2 depicts the fat and oil preference of CAD subjects. Majority of the patients both male and female, consumed sunflower oil, butter and ghee. Sunflower oil (Helianthus annuus L.) is made up of 15% saturated, 85% unsaturated fatty acid.

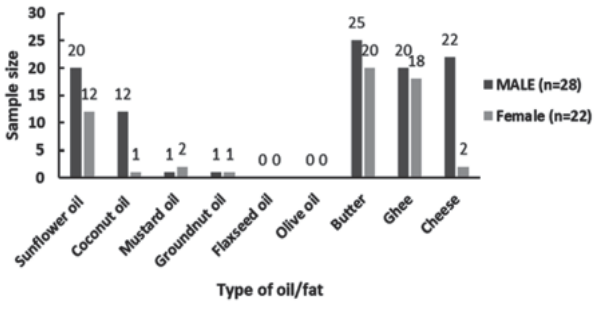

Fig 2: Type of fat and oil consumed by CAD subjects

The unsaturated fatty acid consists of 14-43% oleic and 44–75% linoleic acids (omega–6 fatty acid)[15] which is a parent compounds for arachidonic acid (20:4ω6), is produced in excess can lead to inflammation, chronic disease and cancer.[16] Whereas, oleic acid is a mono-unsaturated omega-9 fatty acid which is a major component of olive oil and has hypotensive or blood pressure reducing effects.[17] On the other hand, majorly butter comprises of oleic acid (approx. 19%) and palmitic acid (approx. 21%). Palmitic acid is a saturated fatty acid present in meat, butter, palm oil and is synthesized endogenously making up the membrane phospholipids and triacylglycerols of adipocytes. It was also noted from the data that none of the participants consumed olive or flax seed oil. Olive oil is not native to India and also not quite suitable for Indian cooking, however it was interesting to note that flax seed in spite of being one of the richest and economical sources of both α-linolenic acid (ALA), phytoestrogen, lignans, as well as soluble fiber, all of which have proven evidence to reduce serum low-density lipoprotein cholesterol concentrations and reduce postprandial glucose absorption was not consumed by any of the subjects. The subjects were not on any omega–3 supplements as well.

CONCLUSION

Omega-3 and omega-6 compete for the same enzymes in their metabolic pathways hence the levels in our diet may influence each other. Fats and oils used in daily cooking are the sources of these unsaturated fatty acids. Omega-3 fatty acids have long been proven to have anti-inflammatory, and cardioprotective functions. Omega-6 is leads to arachidonic acid (AA) which is a precursor for pro-inflammatory and tumour markers. Therefore, it becomes vital to know the source and amount of omega-3 and omega-6 consumptions among population.

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Body Composition Analysis is an Integral Part of the Nutrition Process: A Comparative study

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Abstract

It is possible to infer a person's nutritional status and the presence or absence of certain health conditions by analyzing their body composition. Furthermore, it externally represents aspects of the body. This retrospective analysis compared the means of two groups (male 51 and female 29) with 80 participants aged 21-60 from the northern area in Kolkata and 24 PGS (N). They all had visited a dietitian in north Kolkata to treat obesity and related lifestyle issues. From January 2022 through January 2023, Dr. Trust used his body composition analysis equipment (model 509) to take readings across 12 different body composition variables. Every patient's age, height, and weight had to be recorded before any other composition measurements could be taken. The food plan was then tailored to their specific needs, considering their current weight and any co-morbidities. We conducted an independent sample T-test to compare the male and female groups' means. Therefore, the research hypothesis states that men and women in West Bengal have distinct average body compositions. In contrast, the null hypothesis states that the two populations have similar mean body compositions.

Keywords: Body composition analysis; Nutrition assessments; Obesity; Underweight; Nutrition care process.

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INTRODUCTION

An individual's body composition can indicate their nutritional state and the presence or absence of specific health issues. It also represents bodily characteristics externally.

Body Mass Index (BMI)

BMI is an anthropometric measure of excess weight that shows the grades of weight status in

response toan individual's height. Hence, BMI is body mass in kilograms divided by the square of the body's height in meters (kg/m^2). This is proportional to the mass and inversely proportional to the square of the size. There is a difference between Asian BMI and other countries' BMI. Asian people are more prone to cardiovascular disorders, which may be the reason for the lower cut-off value: overweight 23.0-24.9, obesity-I >25, and obesity-II >30.[1-2]

Basal Metabolic Rate (BMR)

Energy expenditure can be calculated by monitoring the rate of thermogenesis, the process by which the body produces heat. The basal metabolic rate (BMR) often decreases with age and a loss of muscle mass.[5] Building muscle has been shown to raise basal BMR. It was once believed that aerobic fitness through cardiovascular exercise influenced BMR. However, lean body mass is inversely related to BMR, but burns, fractures, infections, fevers, and other acute diseases can all increase BMR.[3-5]

Body fat (BF%)

BMI cannot conclude on a body's fat percentage or adiposity. BF% can predict CVD and other metabolic syndromes better than other body composition parameters. High BF%, both in general and central, is very common in Indians. They also have less muscle, lean and skeletal mass than other population categories defined by WHO. Women population globally contain ~10% more body fat than men generally. A BF% <18 is for males, and BF% <25 is for females, have been considered a reference or standard among Indians.[4]

Table 1: Male vs. female body fat percentage

Classification	Male	Females
Acceptable	18-25	25-31
Fitness	14-17	21-24
Athletics	6-13	14-20
Essential	2-4	10-12

Fat Mass (FM)

Fat mass is the weight of the body fat. Body fat grows with age but begins to decline gradually after age 70. Compared to BMI, which is affected by muscle mass, Fat Mass Index (FMI) is a more reliable indicator of whether a person is overweight. Fat mass index = FM in kilogram/height^2 (meter^2).[6]

Lean Body Mass (LBM)

Lean body mass, or fat free mass, is the difference between the body's total weight and fat mass. Lean body mass is the sum of total body water and dry lean mass. There is a common way of gaining lean muscle where lean is meant 'no fat,' but all muscles are lean muscles in the human body. To understand in gross, we can say that LBM is the total weight of all organs, skin, bones, and most importantly, body water and skeletal muscle mass. Cardiac and smooth muscles under LBM cannot be grown biologically through diet and exercise, but skeletal muscle can be managed by diet and body building exercise.[6]

Muscle Mass (MM/SMM)

Muscle mass, or skeletal muscle mass alone, is often used to indicate a person's dietary and physical activity levels regarding health and illness. Muscle mass is a constant determined by the amount of fat found within muscle cells and the amount of contractile and cytoskeletal proteins. Conditions like these suggest that skeletal muscle contractile activity may be a more sensitive diagnostic indicator, especially in chronic disease. In such cases, it could affect muscle mass. One such correlation is between weaker forearm muscles and an increased risk of death or illness.[7-9]

Body Water (BW)

TBW, or Total Body Water, is the primary constituent of lean body mass. From a maximum of 75% water at birth, the average adult body contains between 50-60%, with the percentage dropping to under 40% in obese adults. Water makes up about 73% of the body in adults, and the total water is found within the FFM. Water makes up about 57% of the body in a fully grown adult.[10]

Role of Protein

Protein is essential for various bodily processes, including blood clotting, fluid balance, hormone, enzyme production, eyesight, cell repair, etc. Along with water, it is a primary component of muscle and can be found throughout the body, including the brain and heart. At 15% of the average man's body weight, protein makes up a sizable portion of a healthy adult's mass (around 11 kg).[11-13]

Bone Mass (BM)

According to genetic research, Peak Bone Mass

(PBM) accounts for 60% of the human body. It is influenced by dietary calcium and vitamin D levels, medication use, obesity, physical activity, and certain chronic conditions such as type 1 or type 2 diabetes, inflammatory bowel disease, and cystic fibrosis.[17] Obesity may be linked to Vitamin D in sufficiency and secondary hyper parathyroidism because of the decreased availability of Vitamin D3 from cutaneous and dietary sources due to its deposition in body fat compartments.[14-16]

METHODS AND MATERIALS

A two group (male vs. female) retrospective comparative study that compared two means of two independent groups. Eighty northern Kolkata and 24 PGS participants with sedentary activities in the age group 21-60 participated in the study. The body composition data were collected from all visited a dietitian in north Kolkata for the significant complaints of obesity and other lifestyle disorders. The body composition comprised twelve variables measured by Dr. Trust's body composition analysis machine (model 509) from the study period from January 2022 to January 2023. This was the first task to ask every visited patient about their age, height, and weight, followed by the body composition measurements. Later the diet plan was prepared based on their weight and related comorbidities status.

Table 1: Descriptive analysis of all variables related to body composition components of the participants

Analysis	Sex	BMI	Body Fat	Muscle Rate	Body Water	Bone Mass	BMR	Metab. Age	Visceral Fat	Subcuta-neous Fat	Protein Mass	Muscle Mass	Weight without Fat
Mean	M	26.3	23.1	51.3	54.9	2.84	1404	34.9	10.2	21.4	16.4	40.7	56.7
-	F	29.5	37.3	40.1	48	2.5	1225	38.8	9	34.1	12.9	30.2	45
Median	M	25.6	23.8	49	53.4	2.7	1285	35	10	21.3	16.3	34.1	52.8
-	F	28.3	34	37.9	50.4	2.4	1247	35	9	31.4	13.2	30.9	44.3
Standard deviation	M	7.1	10.8	7.2	6.49	0.376	245	15.4	4.91	8.51	2.26	17.1	9.12
-	F	7.54	11	5.48	7.08	0.273	142	14.4	4.28	9.75	2.14	9.2	6.36
Minimum	M	16.3	5	40.4	46.9	2.3	1072	17	3	10	13.3	18	42.4
-	F	15.8	10.6	33.7	36.8	2	909	23	2	10.9	10.2	13.2	35
Maximum	M	38.6	37.7	65.8	68.2	3.6	2026	80	18	33.8	20.1	73.8	74.5
-	F	46.3	50	52.2	63.9	3	1409	63	16	45.4	17.8	42.2	57.1
Skewness	M	0.198	-0.362	0.514	0.636	0.583	0.71	1.18	-0.071	-0.091	0.296	0.572	0.42
-	F	0.349	-0.822	1.43	0.443	0.298	-0.455	0.428	0.003	-0.775	0.647	-0.143	0.649
Std. Error skewness	M	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333
-	F	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434

Table 2: Independent Sample T-test related to body composition components of the participants

Variables	Tests	Statistic	df	p	Type of Effect Size	Effect Size
Body Weight	Welch's t	0.521	70.2	0.604	Cohen's d	0.117
	Mann-Whitney U	738		0.992	Rank biserial correlation	0.002
BMI	Welch's t	-1.908	55.4	0.062	Cohen's d	-0.447
	Mann-Whitney U	563		0.078	Rank biserial correlation	0.239
Body Fat	Welch's t	-5.572	57.4	<.001	Cohen's d	-1.299
	Mann-Whitney U	299		<.001	Rank biserial correlation	0.596
Muscle Rate	Welch's t	7.787	71.4	<.001	Cohen's d	1.743
	Mann-Whitney U	135		<.001	Rank biserial correlation	0.817

table cont...

Body Water	Welch's t	4.323	54.3	< .001	Cohen's d	1.017
	Mann-Whitney U	378		< .001	Rank biserial correlation	0.489
Bone Mass	Welch's t	4.711	73.3	< .001	Cohen's d	1.048
	Mann-Whitney U	337		< .001	Rank biserial correlation	0.544
BMR	Welch's t	4.15	77.9	< .001	Cohen's d	0.897
	Mann-Whitney U	445		0.003	Rank biserial correlation	0.399
Metabolic Age	Welch's t	-1.12	61.5	0.267	Cohen's d	-0.258
	Mann-Whitney U	625		0.251	Rank biserial correlation	0.156
Visceral Fat	Welch's t	1.1	65.1	0.275	Cohen's d	0.251
	Mann-Whitney U	643		0.331	Rank biserial correlation	0.131
Subcutaneous Fat	Welch's t	-5.837	52.1	< .001	Cohen's d	-1.383
	Mann-Whitney U	277		< .001	Rank biserial correlation	0.625
Protein Mass	Welch's t	6.78	61	< .001	Cohen's d	1.565
	Mann-Whitney U	188		< .001	Rank biserial correlation	0.746
Muscle Mass	Welch's t	3.575	77.8	< .001	Cohen's d	0.766
	Mann-Whitney U	501		0.017	Rank biserial correlation	0.323
Weight without Fat	Welch's t	6.684	74.6	< .001	Cohen's d	1.479
	Mann-Whitney U	200		< .001	Rank biserial correlation	0.730

Note. $H_a\ \mu_{Male} \neq \mu_{Female}$; ES means Effect Size

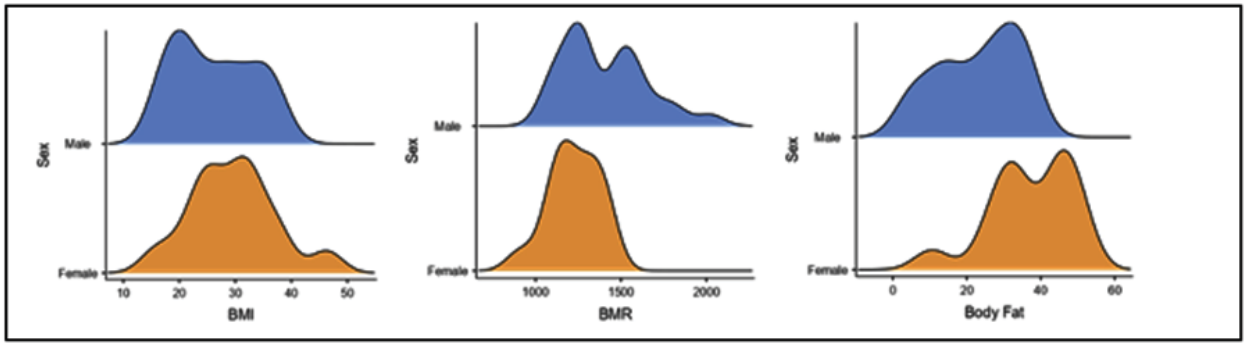

Fig. 1: Male vs. Females: Graphical analysis of BMI, BMR, and BF%

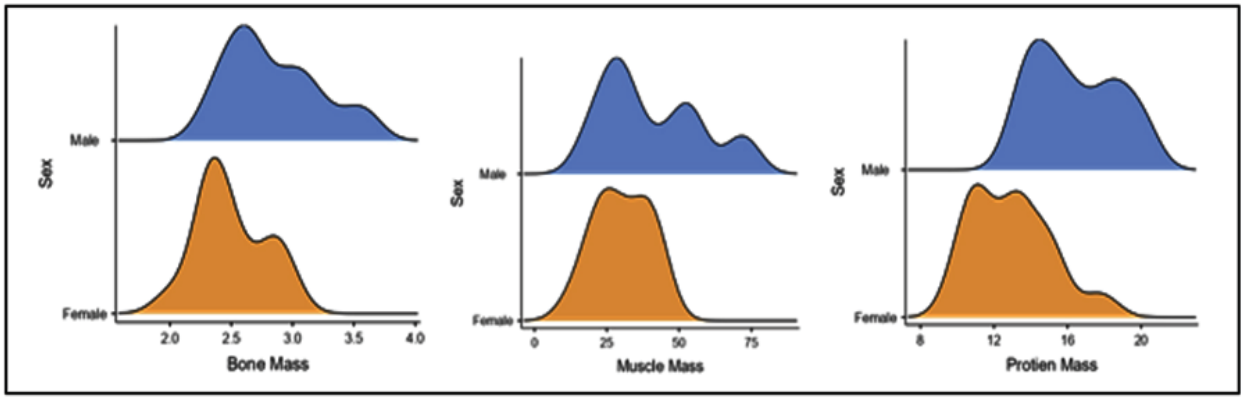

Fig. 2: Male vs. Females: Graphical analysis of BM, MM, and PM

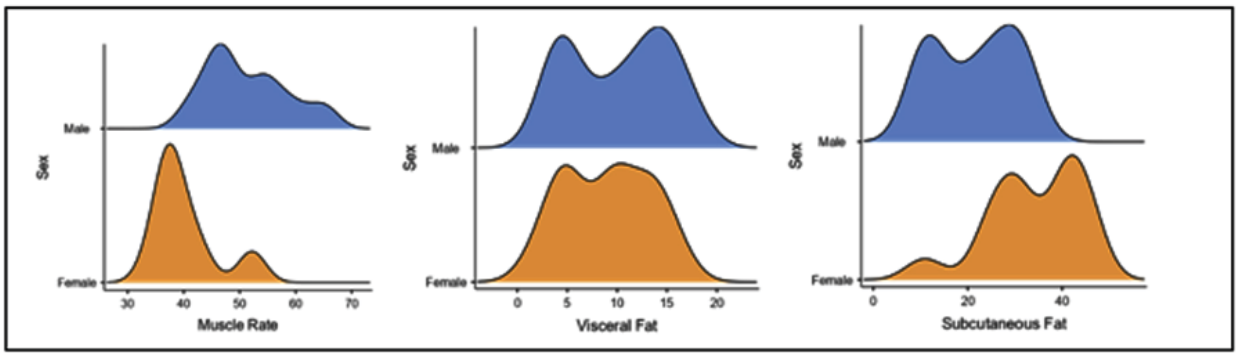

Fig. 3: Male vs. Females: Graphical analysis of MR, VF, and SF%

RESULTS AND DISCUSSIONS

Table 1 shows the descriptive analysis of both groups, including mean, median, standard deviation, and skewness. Table 2. All body composition variabl esexcept body weight, BMI, metabolic age, and visceral fat are statistically significant. In such variables, we performed an independent sample T-test to compare the two means of the male vs. female group. So, the null hypothesis: The means for the male and female body composition in the populations of West Bengal, are the same, whereas the research hypothesis: The means for the male and female body composition in the populations of West Bengal, are different.

In our study, except for four variables (Table 4), all p-value was less than 0.05; hence null hypothesis is rejected, and the research hypothesis is accepted. Welch's t and Mann-Whitney U were tested to cross check the significance of both groups in the Independent T-test. We also presented (ES) effect size regarding Cohen's d and Rank biserial correlation. Effect size is essential to quantify the differences between means and the relationships between groups and variables.

CONCLUSION

Body composition analysis is an essential and integrated part of the nutrition care process. Precisely, measuring various components of body composition should be the mandatory task under the nutrition assessments while a patient suffering from obesity or lifestyle disorders. Even an underweight or normal person should have a mandatory body composition assessment with future needful actions. Sports persons and body builders need periodical estimates of this. Overall, males and females must carefully consider changing body composition while reducing or gaining weight, apart from the indirect progress of other comorbidities.

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Waste Utilization of Farm Produce for Nutritional Improvement: A Tomato Pomace Powder Biscuit

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Abstract

Large amount of farm produces, particularly vegetables and fruits, are processed. Tomato is processed mainly into puree, paste, ketchup, juice. During that a by product, known as tomato pomace (TP), is generated. Drying increase the shelf life of TP. Dried TP is carrier of numerous health beneficial bioactive substances. Consumption of bakery products is increasing. Increasing health consciousness and easy modification of bakery products has led to their development as therapeutic products. Thus proposed study was planned to utilize TP for development of biscuit and evaluate its nutritional composition and shelf life. Dried TP was powdered (TPP) and used for product optimization. For that, Maida was replaced with TPP at various levels in the commercial biscuit formula and evaluate sensorily (6 penalists x 3 times) using composite scoring test. Later on, spices were added at different levels to improve test. Ten percent TPP along with Oregano powder, Chilli flax and Garlic powder at 1% level and Black pepper powder at 0.5% scored the highest thus considered as Experimental Biscuit (EB). The biscuit could store up to two months at room temperature in plastic bag. Raw material, CB and EB were analysed for various nutrients using standard methods. The fiber content were increased by 2023% in TPP biscuit as compared to control. Thus developed biscuit could be useful for person suffering from lifestyle diseases. The mineral control was also increased by 227% that make biscuit more nutritious.

Keyword: Health food; Biscuit; Tomato pomace powder; Farm produce waste utilization.

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INTRODUCTION

Large amount of farm produces, particularly vegetables and fruits, are processed into juice, paste, powder, pieces etc. because of huge seasonal production and perishable nature. They are carrier of numerous nutritional and health beneficial bioactive substances, thus are very important components of the human diet. Tomato (*Lycopersicon esculentum*) is one of the most consumed vegetables worldwide in both form, fresh as well as processed products. Tomatoes are among the most popular vegetables

in our country. Tomato is also one of the main source of minerals, vitamins and antioxidants (like carotenoids, flavonols, vitamin C and tocopherol), potassium, vitamins D, K and from the B group as well as dietary fibre (Bożena 2017 and Deepak *et. al.* 2018).[1,2]

The food processing industry produces large quantities of waste coproducts. (Kamaliya 2021). Tomato is processed mainly in to tomato puree, paste, ketchup, juice. During that a by product, known as tomato pomace, is generated. This by product represents about 4% of the fruit weight. Tomato pomace consists of the dried and crushed skins and seeds of the fruit (Bhat *et. al.* 2017). This by product or waste is just disposed and allowed to spoil which increases landfill costs and concerns about solid waste (Deepak *et. al.* 2018).[2] Drying process (convection or freeze drying) has been shown to be the most favourable pre-treatment for the preservation of fruit and vegetable processing industry by products (Jelena 2016).[5] Dried tomato pomace, is considered as a potential food ingredient because of high dietary fibre, phenolics content, valuable oils, vitamins and secondary metabiolites. Keeping in view the above mentioned nutritional value of tomato pomace and its subsequent drying to reduce its disposal problem, it can be used in different products after its drying (Bhat *et. al.* 2017).[4]

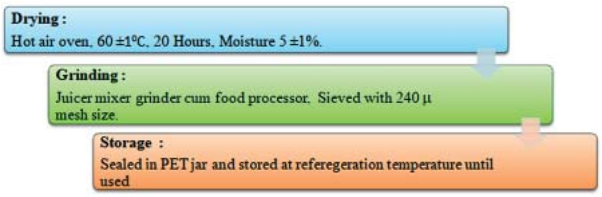
In present scenario, there is an increasing demand for conversion of fruit and vegetable wastes into useful products as well as to minimize environmental impact of these by products (Bhat and Ashan 2015).[6] Changes in the socio-economic conditions have increased the domestic demand and consumption of bakery products. Increasing health consciousness and easy modification of bakery products has led to their development as therapeutic products suitable to individual needs (Kamaliya and Rema 2016).[7] Successful incorporation of tomato pomace into bakery products that deliver physiologically active components represents a major opportunity for food processors providing the consumer a healthy wheat based product to choose from which is currently lacking in the marketplace. Keeping in view the bioactive potential and health benefits of tomato pomace, the proposed study was undertaken to investigate the utilization of tomato pomace for development of wheat based biscuit.

MATERIALS AND METHODS

Tomato pomace was dried and powdered then used for the development of biscuit. The biscuit was studied for their shelf life and nutritional composition.

Preparation of tomato pomace powder

Tomato pomace, obtained after juice extraction for ketchup preparation, as a part of experiential learning for the students for commercial purpose was collected from the Center of Fruit Processing, Department of Horticulture, B A College of Agriculture, Anand Agricultural University, Anand, Gujarat, India. For juice extraction, tomato was obtained from the local market, cleaned, cut in to pieces and juice was extracted in juicer. The pulp left was dried and converted to powder as shown in Fig. 1 and used for further analysis and product development.



Product development

Biscuit was developed in the laboratory following scientific method as detailed below.

Recipe Optimization

To develop biscuit, good quality raw materials of specific brand were purchased from the commercial market of Anand. That were cleaned, filled in airtight PET jar, stored at refrigeration temperature and used throughout the study. The perishable materials like Maida were purchased as and when required of same brand. Fresh glass distilled water was prepared in the laboratory and used to prepare the biscuit. Recipe namely sweet and salty biscuit (Patel *et. al.* 2018) were selected for modification on the bases of survey of local bakeries and successfully prepared in the laboratory conditions. Thereafter, TPP was replaced at different levels into Maida in the formula and biscuits were prepared.

Sensory Evaluation

Biscuits produced after every change were analyzed for sensory attributes and one level was selected for further experimentation. For that samples of biscuits were randomized and presented in foil covered glass dishes to trained panelists on the next day of preparation (*i.e.* day 1). Panelists were supplied with RO water for cleansing the palate between samples. Product evaluation was carried out under 'day light' illumination and in

isolated booths within the laboratory. Each sample was tasted 18 times (*i.e.* 6 panelists x 3 replications). A sensory judging panel was constituted with six panelists from among the faculties, staff and students of the School of Baking, Polytechnic in Food Science, College of Food Processing Technology as well as Dairy Science. The panelists evaluated the volume, crust colour, crumb colour, taste and aroma, mouth feel and over all acceptability of the biscuits using composite scoring test (prescribed by CFTRI, Mysore).

Primary trials

Biscuits were prepared by replacing Maida with TPP at 5, 10 and 15% level in the formula. Biscuit prepared using the commercial formula (*i.e.* 0% TPP) served as the control biscuit (CB) and was used for comparison. The biscuits produced were analysed for sensory attributes. The sensory score assigned by panelists were analysed statistically. The biscuit that scored the highest among TPP incorporated biscuit was selected for further refinement. Replacement rate of newly introduced raw ingredients were narrowed down in such a way that percent replacement of TPP of "selected product" remains some were in the middle.

Taste Improvement

Panellists commented to improve the taste. For that it was decided to add Oregano powder, Chili flakes, Garlic powder and Black pepper powder. Repeated trials of biscuit preparation was carried out with different levels of these ingredients and one level was selected on the bases of sensory evaluation. That was carried out as similar to primarytrials.

Final Selection

For that, trials of biscuit preparation were carried out by replacing TPP with Maida at 5, 7.5, 10 and 12.5% and evaluated as similar to taste improvement. The biscuit ranked the highest overall acceptability considered as the Experimental Biscuit (EB) and used for subsequent study.

Storage study

That was carried out to know the length of preservation for commercial point of view. Finally selected TPP replaced biscuit and control biscuit were packed in three types of packaging materials *i.e.* polyethylene bag, aluminum foil and plastic container and preserved at ambient and refrigerated temperature. That were analysed sensorily until found acceptable at the 15 days interval.

Nutritional Evaluation

To guesstimate the health beneficial effect of developed biscuit moisture (AOAC 1984),[9] protein (Oser 1976),[10] fat (Soxhlet), carbohydrate (by difference), fiber (kit method - Sigma Kit no. TDF 100 A-method was based on Pak *et. al.* 1989),[11] ash (AOAC 1984)[9] content of control and developed biscuits were determined.

DATA ANALYSIS

The standard SPSS program was run to analyse the data. All the data were tested for significance using the ANOVA/Duncan's test (Steel and Torrie 1980).[12]

RESULTS AND DISCUSSION

Present study was planned to utilize the farm produce processing waste. For that biscuit was developed using TPP and evaluated for their shelf life and also assessed its nutritional quality. The results obtained are discussed below.

Primary Selection

Composite scoring test was conducted for the selection of replacement level of TPP. The results of sensory evaluation obtained are depicted in Table 1. However, TPP at 10% level scored the highest among all the TPP replaced biscuits. Thus it was decided to prepare biscuits with 5, 7.5, 10 and 12.5% replacement levels with TPP for final selection.

Table 1: Sensory score of biscuit prepared by replacing Maida with different levels of TPP

Character Product	Volume	Crust characteristics	Crumb colour	Crumb texture	Taste and aroma	Mouth feel	Over all acceptability
	-10	-10	-10	-20	-30	-10	-10
				Primary trials			
Control#	7.39[a]	7.06 [a]	7.14 [a]	14.56 [a]	20.67 [a]	6.94 [a]	8.06 [a]
	± 0.32	± 0.24	± 0.38	± 0.53	± 1.00	± 0.29	± 0.21

table cont...

5% TPP	6.33^{ab}	6.06 ^{b}	6.00 ^{b}	11.56	16.83 ^{b}	4.94 ^{b}	5.33 ^{b}
	± 0.27	± 0.23	± 0.30	± 0.64	± 1.00	± 0.29	± 0.39
10 % TPP	6.72^{ab}	6.06 ^{b}	6.08 ^{b}	11.89	14.33 ^{b}	4.92 ^{b}	5.67 ^{b}
	± 0.28	± 0.26	± 0.27	± 0.49	± 0.62	± 0.31	± 0.34
15%TPP	6.56^{b}	5.94 ^{b}	5.86 ^{b}	10.89	15.67 ^{b}	5.11 ^{b}	5.25 ^{b}
	± 0.28	± 0.36	± 0.34	± 0.99	± 1.07	± 0.44	± 0.37
F Value	2.47	3.55	3.21	5.47	8.4	8.45	16.13
CV%	18.17	18.71	22.28	23.9	23.64	26.12	23.15
Addition of spices (test improvement)							
Control#	7.11 ^{a}	7.17 ^{a}	7.25 ^{a}	14.83 ^{a}	22.33 ^{a}	7.89 ^{a}	7.75 ^{a}
	± 0.35	± 0.41	± 0.34	± 0.68	± 1.04	± 0.35	± 0.26
5% TPP	7.39 ^{a}	6.50 $^{a\,b}$	6.58 $^{a\,b}$	14.11 $^{a\,b}$	15.67 $^{a\,b}$	5.03 ^{b}	5.42 $^{a\,b}$
	± 0.34	± 0.34	± 0.35	± 0.64	± 1.38	± 0.59	± 0.46
7.5% TPP	7.17 ^{a}	6.17 $^{a\,b}$	6.08 $^{a\,b}$	13.33 $^{a\,b}$	16.25 ^{b}	5.14 ^{b}	6.06 $^{a\,b}$
	± 0.35	± 0.34	± 0.38	± 0.94	± 1.70	± 0.63	± 0.46
10%TPP	7.28 ^{a}	6.78 $^{a\,b}$	6.97 $^{a\,b}$	13.44 $^{a\,b}$	18.75 ^{b}	5.42 ^{b}	6.56 $^{a\,b}$
	± 0.41	± 0.44	± 0.27	± 0.68	± 1.31	± 0.52	± 0.40
12.5% TPP	7.06 ^{a}	6.00^{b}	6.22^{b}	12.89^{b}	16.67 ^{b}	5.11 ^{b}	5.83^{b}
	± 0.40	± 0.32	± 0.38	± 0.67	± 1.77	± 0.64	± 0.53
F Value	0.13	1.58	2.02	1.08	3.45	4.84	4.34
CV%	21.89	24.25	22.2	22.59	34.63	41.26	28.92
Final selection (pooled of 3 trials)							
Control#	7.12 $^{b\pm}$	6.80 ^{c}	6.82 ^{c}	13.76^{bc}	20.06^{bc}	6.54^{c}	6.57^{d}
	0.16	± 0.16	± 0.15	± 0.26	± 0.53	± 0.17	± 0.17
5% TPP	7.20^{b}	6.89 ^{b}	6.81 ^{b}	13.94 ^{a}	20.78 ^{a}	6.91 ^{a}	6.99^{ab}
	± 0.13	± 0.10	± 0.10	± 0.26	± 0.43	± 0.14	± 0.12
7.5% TPP	7.51 ^{b}	7.44 ^{c}	7.26 ^{c}	14.81^{bc}	22.80^{bc}	7.48^{bc}	7.66^{c}
	± 0.13	± 0.11	± 0.13	± 0.25	± 0.45	± 0.16	± 0.14
10%TPP	7.98 ^{a}	7.84 ^{a}	7.71 ^{a}	15.26 ^{a}	23.00 ^{a}	7.53 ^{a}	7.58 ^{a}
	± 0.10	± 0.13	± 0.12	± 0.22	± 0.30	± 0.13	± 0.14
12.5% TPP	7.43 ^{b}	7.25 ^{b}	7.19 ^{b}	14.56 ^{b}	21.42 ^{b}	7.15^{ab}	7.20^{bc}
	± 0.14	± 0.12	± 0.13	± 0.29	± 0.48	± 0.16	± 0.15
F Value	6.5	11.72	8.58	5.76	8.2	7.55	9.52
CV%	13.08	12.57	12.96	13.1	15.13	15.39	14.81

TPP = Tomato Pomace Powder

#Control = 100% Maida (Baker's percentage)

All the replacements are based on baker's percentage

Values are Mean ±SEM scores of a composite scoring test by a panel of 6 judges X 3replications

Means bearing the same superscript within the column do not differ significantly ($p \leq 0.05$),

Values in parentheses are the number of maximum scores

Taste Improvement

Among various trials carried out with varying levels of spices panel lists preferred biscuit prepared with addition of Oregano powder, Chilli flax and Garlic powder at 1% level and Black pepper powder at 0.5%, the most. The sensory score obtained is depicted in Table 1. Along with spices 10% TPP replaced biscuits scored the highest including control. The formula standardize for biscuit preparation is given in Table 2.

Table 2: Formula for simple and finally selected TPP replaced biscuit

Product	Control Biscuit	TPP Replaced Biscuit
Ingredients	**Quantity (baker's percentage)**	
Flour	100	90
TPP	Nil	10
Shortening	40	40
Sugar (powdered)	20	20
Ammonium bicarbonate	4	4
Salt	2	2
Ajwain	1	1
Cumin seed	2	2
Oregano	0	1
Chilli flaks	0	1
garlic powder	0	1
Black paper powder	0	0.5
Milk	20	20

Final selection

For the final selection of level of TPP replacement, biscuits prepared by replacing *Maida* with narrow range incorporation of TPP were analyzed for various sensory attributes. The results obtained are presented in Table 1. The results indicated that the panelists gave more score to TPP replaced biscuits than control biscuit (containing no TPP) for all the sensory characteristics. However the highest score for all the sensory attributes was found for the biscuits with 10% TPP replacement. Therefore, it was considered as experimental biscuit and used for further experimentation.

Different researchers found the acceptable level of TPP addition from 4 to 7.5% (Basma e*t. al.* 2020, Bhat and Ashan 2015, Ahmad *et. al.* 2017, Isik and Topkaya 2016).[13,6,14] However that is less than observed in the present study. Basma *et. al.* (2020)[13] reported that, all the sensory evaluation characters; taste, colour, appearance, crispness, and overall acceptability, had significant difference between the control sample and biscuit samples which substituted with 2.5, 5, and 7.5% of TPP. The results of the present study are in agreement with that but not in agreement with Bhat and Ashan (2015), whorevealed that overall desirability sensory scores were not significantly different between control and tomato pomace powder incorporated cookies.

Storage study for TPP biscuit

TPP biscuits packed in plastic bag and plastic container found acceptable sensorily up to 2 months. However, biscuit packed in aluminum foil found acceptable up to 2½ month. Observations made are concluded in Table 3. Ahmed *et.al.* (2017)[15] reported that biscuits prepared with 2, 4 and 8% TPP incorporation and stored at room temperature found acceptable upto 45 days.

Table 3: Acceptability of control and finally selected TPP biscuit at different intervals during storage using Sensory evaluation.

Day / Week	Result
0 Day to 4th Fortnight	Found acceptable in all the packaging materials and at both the temperatures
5th Fortnight	Both biscuit packed both in Polyethylene bag and Plastic container at both the temperatures i.e. Room temperature and Refrigeration temperature found not acceptable while both types of biscuit packed in aluminum foil at both storage conditions found acceptable
6th Fortnight	Both types of biscuit (Control and TPP) packed in aluminum foil at both the temperature i.e. Room temperature and Refrigeration temperature scored less than 5 i.e. not acceptable

Nutritional Composition

Control and developed biscuit were analyzed for various nutrients in 3 replications. Results obtained are presented in Table 4.

Table 4: Nutritional composition of control and finally selected TPP replaced biscuit

Nutrient	Flour	TPP	Control Biscuit	TPP Biscuit	% Change
Moister (g%)	13.13	8.11	9.12	10	9.28
	± 0.15	0.8	0.5	0.58	0.82
Protein (g%)	11.27	5.5	5.9	5.46	-8.56
	± 0.11	0.56	0.1	0.31	0.85

table cont.....

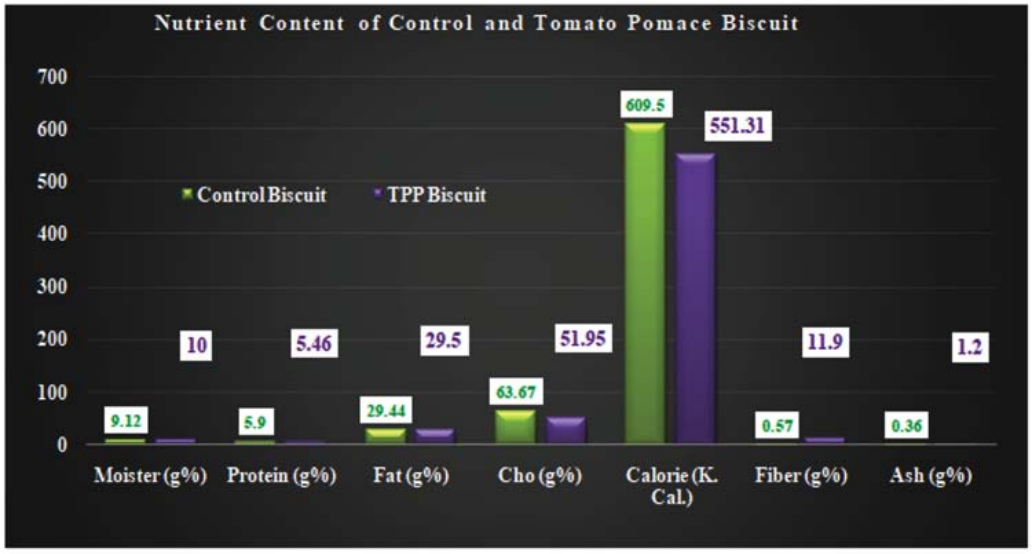
Fat (g%)	1.52	2.13	29.44	29.5	0.44
	± 0.09	0.35	0.5	1.15	0.05
Carbohydrate (g%)	85.34	24.05	63.67	51.95	-18.51
	± 1.22	0.98	3.39	3.19	0.6
Calorie (K. Cal.)	400.82	156.35	609.5	551.31	-9.55
	± 9.66	4.84	8.78	10.58	0.32
Fiber (g%)	1.06	65.15	0.57	11.9	2023.21
	0.56	2.35	0.05	0.91	22.5
Ash (g%)	0.7	3.16	0.36	1.2	227.03
	0.05	0.53	0.05	0.05	6.75

TPP = Tomato pomace powder

Values are Mean ± SEM of 3 replications

Value for carbohydrate calculated by difference

All the data except moisture is reported on dry weight bases



The fiber content was increased by 2023% percent in TPP biscuit as compared to control. Thus developed biscuit could be useful for person suffering from lifestyle diseases. The mineral content was also increased by 227% that make biscuit more nutritious.

The dietary fiber content of TPP was observed 65.15% which is slightly higher (62.04% and 59.94%) than reported by Jellena *et. al.* (2016) and Isik and Topkaya (2016), respectively. Value of ash content (3.16%) was similar (3.49%) to that of observed by Isik and Topkaya (2016). However, value for carbohydrate (24.05%) was found similar (25.39%) to Jellena *et. al.* (2016).

CONCLUSION

After repeated trials of biscuit preparations followed by sensory evaluation carried out by a panel of experts, the final formula developed and accepted was biscuit with replacement of 10% TPP into Maida and addition of Oregano powder, Chilli flax and Garlic powder at 1% and Black pepper powder at 0.5%. The developed biscuits could be stored upto 2 months at room temperature in plastic bag and 2½ months in aluminium foil. The developed biscuit contained very high amount of fiber and ash. Thus it can be replaced the commercial biscuit in chronic diseases like hyper cholesterolemic, obese & diabetic subjects after clinical trials.

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Review Article

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To assess the Knowledge Regarding Food Labelling among Youth of Indore City

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Abstract

A survey was conducted among they younger population residing in the Bhanwar kuan zone of Indore city region, aimed to assess their level of awareness and comprehension regarding food labelling, as well as evaluate the effectiveness of different components of food labelling. The current research focuses on evaluating the behavior, consciousness, and understanding of young individuals when it comes to food labeling. This is crucial because young people represent the future consumer base. The main objective of this study is to gain insights into how well people, especially the youth, comprehend the information provided on nutritional labels and whether they consider it when making purchasing decisions.

Additionally, the study aims to educate participants on the importance of inter preting nutritional information from labels effectively.

Keyword: Consumer awareness; Food label; Food label knowledge; Food labelling effect.

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INTRODUCTION

Food labeling is a practice that provides consumers with vital information about a food product, empowering them to make informed choices. It includes details about ingredients, nutrition facts, all ergens, and other relevant product information. Labels serve as a source of essential information such as product name, expiration date, maximum retail price, manufacturing date, ingredients, and nutritional content. The purpose of including nutritional information on labels is to protect consumer health and maintain dietary standards.[1] By understanding nutrition, consumers

can effectively manage their intake and avoid both under nutrition and over nutrition.

Health conscious individuals benefit from labels by improving the quality of theirdiet and reducing the consumption of energy, fats, sugars, sodium, and cholesterol. The primary goal of food labeling is to provide consumers with the knowledge necessary to make informed decisions about the food they consume.[4] Governments regulate labels to ensure accuracy, and labels can also in corporate marketing claims like "low fat" to appeal to health conscious consumers. Labels serve multiple functions, including conveying information, promoting brands, aiding advertising, managing gallergies, and ensuring food safety.[8] They enable consumers to make well informed choices by presenting information through packaging or labels. Nutrition labels can utilize numeric or graphical formats to effectively communicate with consumers. Health claims on labels establish a connection between food and disease prevention, providing additional nutritional information and enhancing consumer awareness. Overall, food labels play a crucial role in instilling trust, maintaining health standards, and promoting informed decision making among consumers.[7]

METHODOLOGY

A research project was carried out between January–May 2023 at the Bhanwar kuanarea of Indore city, Madhya Pradesh, involving a group of 50 consumers aged between 18 and 25. The participants were selected using a purposive random sampling method, ensuring a diverse representation. Data collection was accomplished through the utilization of a self-structured and pre-tested questionnaire, which underwent modifications to align with the objectives of the study. A preliminary study was conducted on a small sample of 20 individuals to identify the patterns of the experimental variables and to assess the knowledge and attitudes of young people towards food labeling. To achieve this, a questionnaire was designed, consisting of specific questions related to food labeling, which participants were requested to complete and provide responses. The findings from this pilot study served as a guiding frame work for further investigation and analysis of the research problem, and also indicated that there were minimal changes in the trends concerning food labeling.

RESULTS

There is limited attention among consumers in developing countries regarding their awareness of the information provided on food labels. To address this gap, the present study aimed to analyze the knowledge, awareness, attitudes, and practices of young individuals concerning food labeling. The study involved a sample size of 50 participants, with the majority were being females, accounting for 64% of the sample, while males accounted for 36% within the same age range. They demonstrated a certain level of competence in interpreting the information provided on food labels, enabling them to make informed choices based on their individual requirements. A significant proportion of participants, 88% in total, reported checking food labeling. Among the aspects they focused on, price was prioritized by 84%, quantity by 70%, and nutritional information by 78%.

Specifically, participants tended to check the protein content first (46%), followed by total fat (26%), sodium content (1%), carbohydrates (20%), and overall fat, as indicated in the nutritional label section of food packaging. In addition, the study included questions related to images to assess participants' awareness of specific symbols suchas QR codes, barcodes, food declaration symbols (green/brown color tags), and garbage can signs. The results showed that approximately 60% of the participants demonstrated a high level of awareness regarding these symbols. Furthermore, participants exhibited a positive response towards checking the maximum retail price (MRP) of food products (84%), indicating a consistent practice of price verification before making purchases. Additionally, 70% of participants cross checked the weight of prepackaged food, with 58% relying on the quantity mentioned on the food label. The study also revealeda strong belief among respondents in the accuracy of food product labeling, including information related to quantity, nutritional facts, and product guarantees. The majority of participants (98%) consistently checked the expiry date, recognizing its importance in avoiding potential health hazards. However, a small percentage (2%) reported neglecting this aspect. It is crucial for all participants to be aware of and check the expiry date to ensure food safety.

CONCLUSION

Inconclusion, the study findings indicated that

consumers in the Indore region place significant importance on food labels and depend on them when purchasing food. They find the information provided on the labels to be valuable and comprehensive, which empowers them to make informed choices. The study concluded that both the cost of the product and the information on the label play a role in influencing consumer decisions. Notably, the younger generation demonstrated a high level of awareness regarding food labeling, suggesting a positive outlook for future generations.[2] These finding semphasize the crucial role of food labeling in shaping the future of consumer choices. This research focused on examining the awareness of food labeling among young consumers. The results indicated that a significant majority of respondents consistently read food labels.

Interestingly, the findings revealed that the respondents' level of education was not correlated with their knowledge about food labels. Moreover, consumers exhibited a satisfactory level of understanding when it came to interpreting the information presented on food labels. The frequency of reading food labels among the youth was dependent on the specific contents mentioned on the labels.[3] As a result, they were able to interpret the food labels to some extent and make informed choices in selecting food products that aligned with their individual needs.

The small print used for nutritional labeling on food packaging creates a barrier for consumers, hindering their comprehension.[4] To overcome this, it would be beneficial to include only essential information on labels, rather than overwhelming consumers with excessive data. Furthermore, presenting this information in a legible font size that can be easily read would greatly assist consumers.[9] The abundance of information on food labels poses a challenge, as it consumes a lot of time for consumers to read and analyze the details of each packaged food product they purchase, especially considering their busy schedules. Therefore, implementing Front-of-Pack (FOP) labeling, which displays key nutritional information in a clear and easily under standable manner, would greatly help consumers, including those with limited education, in making healthier choices.[5] This approach would significantly reduce the time required by consumers, as they would only need to glance at the front of the package to assess the nutritional value and determine if it aligns with their health goals. Additionally, it is important to plan and implement a comprehensive awareness and educational program focused on food labels to enhance consumer understanding. he use of technical jargon on food labels has been shown tocreate a barrier for consumers.[6] Instead, using simple or straight forward language on the labels can helpmitigate this issue. Educational institutions have acrucial role to play in raising awareness among the wider community about the importance of environmental protection.[3] They can educate individuals about the significance of Ecolabels and how they can impact consumer purchasing decisions. By providing information and promoting understanding of Eco-labels, educational institutions can encourage consumers to make more environmentally conscious choices when buying products.

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Review Article

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National Nutrition Week: A Implement to Reduce Malnutrition

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Abstract

National Nutrition Week is celebrated in India from 1 September to 7 September to create awareness about good nutrition and health by goverment of India since 1982. The objective of the study is to assess the impact and functioning of National Nutrition Week in India. The method of the current study is a narrative review based and data were abstracted from an online data source like research articles, intuitional reports, and press releases. The available study on the relevant topic shows that National Nutrition Week has helped to bring a strong focus on improving nutrition outcomes during the first 1,000 days. National Nutrition Week has enabled a nationwide Jan-Andolan to catalyzing nutrition related behavior change at scale for a positive impact on feeding and health care practices.

Keywords: National Nutrition Week; Rashtriya PoshanMaah; Malnutrition; Government schemes; Nutritional Status.

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INTRODUCTION

According to the Global Hunger Index 2023, the situation in India is getting worse in terms of hunger and India ranks 111 among 125 countries. Thus India is facing a 'serious' level of hunger.[4] The latest National Family Health Survey (2019-21) shows high levels of malnutrition among children under the age of five years. According to the survey, more than 35.5 percent of children are stunted, 19.3 percent are wasted and 32.1 percent are underweight.[5] Anemia was found to be significantly higher (67.1 percent and 57 percent, respectively) in the age group of children under

five and women of reproductive age. Among newborns and young children, there was a decrease in the initiation of breast milk (41.8 percent) and the timely introduction of complementary feed (45.9 percent). Only 11.3 percent of the children get minimum adequate food.[6]

The Global Burden of Disease study for India indicates that 68.2 percent of all deaths among children under the age of five yeas are due to malnutrition.[7] Evidence indicates that a child's poor physical development in childhood is passed on to subsequent generations and is associated with a loss in economic productivity. In a small scale study in India, spacing between births, low birth weight, duration of maternal breastfeeding, maternal age at conception, and education was associated with appropriateness in children under five years of age.[8] It has been found responsible for the lack of physical development.[9]

With the introduction of the Integrated Child Development Scheme in 1975 and the mid-day meal program (now PM Poshan Yojana) in 1995, India has accorded high priority to the fight against malnutrition.[10] The National Nutrition Policy was also launched in 1993 to combat the problem of nutritional deficiency through direct and indirect measures. Similarly, under the National Food Security Act 2013, food and nutritional security in human life was provided by ensuring access to a sufficient quantity of good quality food at affordable prices. But despite these steps, malnutrition among children under the age of five years remains a public health concern.[11]

National Nutrition Week (NNW) is a part of the National Nutrition Mission (POSHAN Abhiyan), which is celebrated every year in September Week. It aims to spread awareness about the importance of nutrition for good health, growth, and economic development.[1] The idea of NNW in India was initiated in 1982 to create awareness about the importance of nutrition in a healthy and sustainable lifestyle.[2] Subsequently, the National Nutrition Mission was launched to reduce stunting and low birth weight among children under five years of age by 2 percent and 1 percent annually to achieve the goal of a 'malnutrition free India' by 2022. Anemia can be reduced by 3 percent. After the launch of the nutrition campaign, the month of September is celebrated as Poshan Maah and the first week of the month were deliberation as NNW.

The objective of the study is to assess the impact and functioning of NNW. Evaluation of the impact of the event will help to find the gaps for improvement.

METHOD AND MATERIAL

A narrative review of the literature was carried out from April to May 2023. Applicable articles were identified by applying search strategies to six academic electronic databases: Scopus, PubMed, Article First, Springer Link, Wiley Online, and Science Direct as well as published institutional reports and press releases. Search terms and keywords included: Nutrition week, Rashtriya Poshan Maah, malnutrition in children, Poshansaptaah, nutrition schemes, NNW, and the Nutritional Status of India. All retrieved titles, abstracts, and full-text publications were studied and screened for importance to the topic. Furthermore, references from retrieved articles were reviewed to identify additional applicable publications. In this research, the study and reports were included within 5 years of publication.

RESULTS AND DISCUSSION

Themes of NNW

Theming is fundamental to the conceptualization and delivery of every successful event theme sets the tone for the entire experience and drives all subsequent planning decisions and activities on NNW. The theme is the first impression people will have of the NNW event.

Table 1: Themes of NNW in the last 5 years

Year	Theme
2018	Go Further with Food
2019	To increase the public's awareness of the importance of good nutrition and position registered dietitian nutritionists as the authorities in nutrition
2020	Eat Right, Bite by Bite
2021	Feeding smart right from the start
2022	Celebrate a World of Flavours

NNW theme is announced by the Indian Government every year.

Activities under NNW

Many activities will be started at the panchayat level under Nutrition Week. Nutrition Panchayat Samitis along with frontline workers – Anganwadi workers, Accredited Social Health Activists (ASHA workers), and Auxiliary Nurse Midwife (ANM) during the Village Health and Nutrition Day to

create awareness about the nutrition of mothers and children at Anganwadi centers and address problems Will work to solve the problem.[12] The campaign to monitor the development of children will be run by state and district level personnel under the 'Healthy Child Competition'.[14] Health camps will be organized to check anemia in adolescent girls. Campaigns will be run with special emphasis on developing nutrition gardens, rainwater harvesting, and traditional diets in tribal areas for healthy mothers and children. Efforts will be made to link traditional diet with local festivals for which 'Amma ki Rasoi' will be organized full of traditional nutritious dishes. Women and Child Development Department through Anganwadi workers; Department of Health and Family Welfare through ASHA workers, ANMs, Primary Health Centers, and Community Health Centers; Department of School Education and Literacy through Schools; Panchayati Raj Department through Panchayat; And through self help groups, awareness will be spread about good nutrition for women and children by involving the Rural Development Department.[11,15]

To effectively combat malnutrition, it is necessary to coordinate all measures from conception to the completion of five years of the child. Achieving ideal nutritional practices by addressing social and cultural barriers requires an effective social and behavior change communication strategy.[16] To address the problem of malnutrition, effective monitoring and implementation of programs and reduction of malnutrition among children will have to be included on a priority basis in the national development agenda. The spirit of NNW should be followed throughout the year for better outcomes related to nutrition among children, pregnant women, and lactating mothers.[11]

Ways to celebrate NNW

There are plentiful ways to celebrate NNW and contribute to the cause of spreading consciousness about superior nutrition:

- ***Seminars organization:*** Host seminars and workshops to educate people regarding the importance of nutrition and its impact on health.
- ***Demonstrations of cooking:*** Arrange cooking sessions that showcase the preparation of nutritious meals using locally available ingredients.
- ***Organizing health camps:*** Set up health camps present free nutrition assessment, counseling, and guidance for persons of all age groups.
- ***Organizing walks for awareness:*** Organize awareness walks or runs to encourage the significance of healthy consumption habits and physical doings.
- ***Challenges about nutrition:*** Launch online or community based challenges that encourage people to try new, healthy recipes and share their experiences.
- ***Activities at schools and colleges:*** Schools can conduct essay and art competitions focusing on nutrition, connecting students with creative knowledge about healthy choices.
- ***Collaboration with farmers:*** Collaborate with local farmers' markets to highlight and encourage the availability of fresh, locally sourced manufacture.
- ***Community gardens:*** Start community gardens where citizens can grow their vegetables, fostering an association with nutritious food.
- ***Organizing of nutrition workshops:*** Host workshops targeting specific groups like pregnant women, mothers, or elderly individuals, addressing their only one of its kind dietary needs.
- ***Organizing webinars:*** Organize virtual webinars featuring nutrition experts, answering questions, and providing realistic advice.
- ***Distribute resources:*** Provide pamphlets, brochures, and digital capital that offer practical tips for eating and meal preparation.
- ***Campaigns on social media platforms:*** Utilize social media platforms to share educational posts, videos, and infographics associated to nutrition.
- ***Collaboration with restaurants:*** Partner with local restaurants to offer extraordinary, health conscious menus or discounts during the week.
- ***Celebrities engagement:*** Collaborate with health conscious celebrities or influencers to spread awareness about NNW.
- ***School outreach:*** Extend the celebration to schools by conducting interactive sessions on the significance of good nutrition.
- ***Health & fitness events:*** Incorporate nutrition related sessions inside health and fitness events to make a holistic approach to well being.

Impact of NNW

- ***Behavioral changes:*** NNW triggers a positive behavioral shift towards healthier food choices and eating habits. The Hindu's raids were on 14 September 2023. According to a report, CSIR along with CFTRI celebrated Nutrition Month on a large scale which had an impact in developing good nutrition habits among school children.[20]
- ***Healthcare cost reduction:*** Promoting preventive nutrition, contributes to reducing healthcare costs associated with diet related diseases. Department of Food Science & Nutrition in Collaboration with ICDS & Krishi Vidnyan Kendra, organized a Low Cost Recipe Demonstration at Vadholi village at Trimbakeshwar in Collaboration with ICDS & Krishi Vidnyan Kendra. Activities like this in many institutions promote the use of cheap and nutritious food grains.[21]
- ***Empowering vulnerable groups:*** The week empowers marginalized communities with the knowledge to combat malnutrition and improve their well being. Various campaigns and activities related to vulnerable populations such as girls, adolescents, and children are carried out this week.[22]
- ***Educational awareness:*** It serves as an educational platform, enlightening individuals about the direct link between nutrition and overall health. Ministries such as Rural Development, Health & Family Welfare, and Panchayati Raj are leading with the Ministry of Rural Development alone recording more than 6 lakh activities under NNW 2023 for awareness about nutrition education.
- ***Collective responsibility:*** NNW reinforces the notion that ensuring proper nutrition is a collective responsibility of society, government, and individuals.[23]

The key Impact of NNW

- NNW celebration has helped to bring a strong focus on improving nutrition outcomes during the first 1,000 days.[1]
- NNW celebration has enabled a nationwide janandol and catalyzed nutrition related behavior change at scale for a positive impact on feeding and healthcare practices.[1,11,17]
- NNW celebration demonstrated that the processes for inter-sectoral convergence are effectively operationalized through in-place institutional mechanisms at multiple levels.[1,2]
- NNW celebration showed that technology can be leveraged for real time monitoring of large scale health and nutrition programs.
- NNW celebration supported the resilience of health and nutrition systems during COVID-19 pandemic.[19]

CONCLUSION

Through National Nutrition Week, the importance and role of a healthy diet for human beings is emphasized. It is shown from the reviewed literature that the impact of NNW has been at a significant level in improving the nutritional issues of the community. The campaigns being run by the institutions during this week promote awareness as well as coordination among all the stakeholders. Sensitivity towards nutrition issues has increased among the public as well as health care professionals. This week can be better utilized by establishing coordination between various departments.

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To assess the Knowledge Regarding Food Safety and Hygienic Practices among Dairy Plant Worker in Indore, MP

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Abstract

Ensuring food safety and hygiene practices in the dairy industry is crucial for the production of safe and reliable dairy products. This research paper aims to assess the knowledge and hygiene practices of dairy plant workers regarding food safety. The study was conducted at Saachi Doodah Dairy in Indore, Madhya Pradesh, with a sample size of approximately 49 workers involved in various roles. A self-structured and pre-tested questionnaire was used to collect data on food safety knowledge and hygiene practices. The research revealed that dairy plant workers have a strong understanding of food safety principles and good hygiene practices. However, there were knowledge gaps regarding food borne illnesses and pest control measures. Immediate action is required to address these gaps through regular training programs covering essential topics.

Keywords: Dairy industry; Dairy plant workers; Food safety; Hygiene practices; Knowledge gaps.

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INTRODUCTION

Ensuring food safety is a critical role in the food industry, encompassing all phases of the food chain from production to consumption. The dairy industry, specifically milk production, plays a vital role in the food supply. However, milk can act as a medium for spreading bacteria and other micro-organisms if proper milking practices are not followed.[1] This research aims to provide an introduction to food safety and hygiene knowledge among dairy workers, highlighting the importance of food safety in the dairy industry and addressing potential hazards associated with dairy products.

Food safety is a scientifically describing that handling, preparation, and storage of food in ways that prevent food borne.[1] This comprises a number of routines that should be followed to avoid potentially severe health hazards. In this way food safety often overlays with food defences to prevent harm to consumers.[4] The paths within this line of thought are safety between industry and the market and then between the market and the consumer. In considering industry to market practices, food safety considerations include the origins of food including the practices relating to food labelling, food hygiene, food additives and pesticide residues, as well as policies on biotechnology and food and guidelines for the management of governmental import and export inspection and certification systems for foods.[8] In considering market to consumer practices, the usual thought is that food ought to be safe in the market and the concern is safe delivery and preparation of the food for the consumer. Overall, awareness of food safety knowledge and hygiene practices can have a significant impact on the quality and safety of dairy products, as well as the success of dairy businesses.[2]

While increasing used of effective technologies, good practices and awareness contributes to reduce incidence, poor quality water, reduced profit margins and increased pollution can lead to increased food and water borne diseases.[2] In poor countries, it is estimated that more than half a million children die every year from diarrhoea. Much of this can be attributed to food and especially animal source food. The WHO estimates of the global burden of foodborne disease is that every year 1 in 10 people become ill from eating contaminated food and 48 million people become ill with foodborne illness, of which 420,000 die each year. As a result of which 33 million healthy lives are lost. In India, most outbreaks of food borne disease are not identified or investigated and can be resolved only after health or economic damage has occurred.[9] Food poisoning outbreak cases have increased from 50 in 2008 to 312 in 2017 in India. Food production operator have the main responsibility to provide safe food to consumer and the workers also plays a crucial role in the preventions of foodborne diseases outbreaks.[5]

METHODOLOGY

A descriptive cross-sectional study was conducted between January and May 2023 at Sanchi Doodah Dairy in Mangalyaan, Indore, Madhya Pradesh. A self-structured and pre-tested questionnaire was used to collect data from approximately 49 workers involved in various roles within the dairy plant. Random purposive sampling technique was employed for sample selection. A pilot study was conducted on 20 samples to assess workers' knowledge of hygienic milk production practices, including food safety related questions and hygiene practice assessment. Data was tabulated in Microsoft Excel sheet. Analysis was done using power BI tool. Results were expressed in terms of percentages, tables, pie charts and graphs using appropriate statistical tests.

RESULT

The results of demographic table, Gender (male 91%) and (Female 9%) that indicate that the majorityof respondents were male, reflecting the gender distribution within the dairy plant workforce. The age distribution shows 16-25 (21%), 25-35 (24%,), 35-45 (24%), 45-55 (24%) and 55-65 (7%) a relatively even representation across different age groups, allowing for a comparison of awareness and adherence to food safety protocols. Most workers had 10-20 years of experience, indicating their valuable knowledge and expertise infood safety practices specific to the dairy industry. Regarding food safety knowledge, (100%) workers demonstrated good understanding of temperature control, separation of raw and cooked foods, storage tanks, milk storage, and milk transportation. However, there was a significant knowledge gap regarding pest control and awareness of food borne diseases, which calls for targeted training programs in these areas. In terms of hygiene practices, (100%) workers exhibited positive behaviour, including maintaining personal hygiene, wearing uniforms, masks, and caps, and practicing proper hand hygiene. They also refrained from consuming food or beverages within the workplace and avoided smoking in the working area. However, a small percentage (7%) of workers did not undergo pre-employment health assessments.

DISCUSSION

This research is based on the study on assessing food safety knowledge and hygiene practices among dairy's workers. The objectives of this research were to assess the knowledge regarding food safety and hygiene practices among workers.

The data on knowledge of food safety shows

that 100% workers had positive response regarding food safety. This result indicates that all respondents have higher level of knowledge in food safety measures. Similar research conducted by Hamed A.F, Mohammed N.A. *et al*, in 2019 in Suhag Governorate, Egypt. This study found that 79.1% of the food handlers had a positive attitude towards food safety, while 20.9% had a negative attitude. They also found that food handlers who had a higher level of knowledge were more likely to report good food safety practices.

On the other hand, the same data also inferred that the knowledge of pest control and foodborne disease among workers. 80% workers had knowledge about pest control, whereas 20% were not having sufficient knowledge about pest control. Besides, allworkers have no knowledge about foodborne disease which indicates a significant gap among the workers regarding these crucial aspects of food safety. Previous research done in Ethiopia by Getachew, L., Seblewongle., K. *et al* in 2018 found that the majority of dairy farmers had low levels of awareness regarding milk born. The researchers suggest that to improves dairy farmers awareness and knowledge and provide training programs. This study also highlighted the importance of addressing the knowledge gaps and improving practices to ensure the production of safe and high quality of milk.

CONCLUSION

In conclusion, the knowledge of food safety and hygiene practices among dairy plant workers plays a crucial role in ensuring the production of safe and high quality dairy products.[3] This research shed light on a concerning issue regarding the knowledge of food safety and hygiene practices among dairy plant workers. Through my research and analysis, it is evident that workers have strong understanding of food safety principles, such as proper handwashing, sanitation procedures, and personal hygiene, which is essential for maintaining a clean and hygienic working environment. It is alarming to note that a significant portion of the workers lacked awareness regarding foodborne illnesses, while a small percentage had limited knowledge regarding pest control measures.[4] The research revealed that dairy plant workers have a strong understanding of food safety principles and good hygiene practices. However, there were knowledge gaps regarding foodborne illnesses and pest control measures. Immediate action is required to address these gaps through regular training programs covering essential topics.[9] Enforcing strict adherence to food safety standards and regulations, along with continuous improvement practices, can enhance food safety and hygiene in dairy plants. Future research should focus on detailed analysis of specific areas where workers lack knowledge or have misconceptions to identify root causes and provide insights for targeted interventions. By prioritizing the knowledge of food safety and hygiene practices, dairy plant operators can produce safe and reliable dairy products, ensuring consumer confidence and protecting public health.

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Review Article

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Spirulina: A Miraculous alga with Pharmaco-nutraceutical Potential as Future Food

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Abstract

Current projections indicate that the world is not on track to accomplish the global nutrition targets, because the Global Nutrition Report says malnutrition in every country on earth. In order to address this malnutrition issue, spirulina can be a better choice as a supplement diet that also fulfills India's protein consumption gap. Spirulina is microalgae that thrive in saline water and gained popularity as one of the "superfoods" due to a range of nutrient content such as proteins, minerals, carbohydrates, and many phytopigments. Medicinal use of the algae has been also mentioned in some ancient texts and formulations of Ayurveda. It is highly sought after in the food industry for coloration and food fortification purposes. The current review aims to provide a pharmaco-nutraceutical approach with all the information on its various characteristics such as nutraceuticals, cosmeceuticals, and pharmacological importance including possible advantages of Spirulina's potential to enhance healthcare.

Keywords: (a18) Algae; Microalgae; Bioactivity; Nutritional; Pharmacological activity; Spirulina; Superfood

Key Messages: As befits a Journal devoted to food, nutrition & dietetics information, for well being and is committed to improving quality of life. This article provides a bag of information for researchers & Health professionals, about Spirulina's high content of macro-micronutrients, and active compounds with their pharmacological properties. As proven by its long history of food uses and recent scientific findings, spirulina is considered safe for human consumption and also considered a future meal to combat malnutrition.

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INTRODUCTION

Nutritional deficiency is increasing in the world becomes a major challenge for mankind. This concern has led to an increase in the popularity of alternative, unconventional aquaculture diets, which include spirulina as a source of protein, vitamins, and minerals supplements. Spirulina is multicellular, photosynthetic prokaryote, filamentous blue-green algae, that prefers to grow in an alkaline aquatic ecosystem. It is one of the first photosynthetic creatures in nature, able to use light

directly for intricate metabolic processes.[1] It has a long history as a dietary supplement. As more and more health conscious consumers and researchers consistently appreciate its exceptional nutritional features and pharmacological characteristics, its popularity is growing on a global scale today. Interestingly, the UF/IFAS from NASA Settles an experiment for the suitability to grow Spirulina in space in 2021 as a bountiful and nutritious food crop for astronauts on long-term space missions and they found that Spirulina behaves in space exactly as it does on Earth.[2]

History of Spirulina

The nutrition from diet plays a major part in Ayurveda since it nourishes the mind, body, and spirit. Therefore, Ayurveda texts (Sanhitas & Nighantu) have been found about to uses of algae, mentioned as Jalmastu or Shaivaal (type spirulina). It is also used in ancient formulations by owing astringent, bitter, sweet, antipyretic, and digestive characteristics (Bhavprash & Dhanvantari Nighantu). Thus, Spirulina has been consumed as food for ages by various populations and has only recently been rediscovered. It was eaten by the Mayas, Toltecs, and Kanembu in Mexico during the Aztec civilization as early as over 400 years ago. Spirulina from Lake Texcoco was collected, dried, and made into a cake for consumption called "Diha" or "Die".[3] In Central Africa, the Chadians (Chad residents) have been consuming spirulina for millennia. When spirulina from Lake Kossorom (Chat) is harvested, it is also sold on the market and used to produce cakes or broths for meals. Moreover, it was also found by French researchers in Lake, trait within the 1960s, it is used as a daily food source after the 16th century. Early in the 1970s, the first large scale production was facilitated, garnering interest on a global scale. Millions of people across the world consume it today, and exploring more in addition to its nutritional worth. Surprisingly, it appears to have discovered a niche in Indian cuisine.[4,5]

Scientific Description

A genus of blue-green algae in the Oscillatoriaceae family is called Spirulina. Blue-green algae are among the most primitive life forms on earth with their cellular structure as a simple prokaryote and have the ability to do photosynthesis like a plant. However, they share features with primitive bacteria because they lack a plant cell wall. Spirulina, the name comes from a Latin word meaning tiny spiral. It is microscopic, spiral shaped, which belongs to photosynthetic bacteria that cover the groups Cyanobacteria and Prochlorophyta. Spirulina as a cyanobacteria typically carries out oxygenic photosynthesis with water as an electron donor and uses carbon dioxide as a carbon source. Spirulina is filamentous, helicoidal trichomes, performs oxygenic photosynthesis, and reproduces by binary fission. It is especially found in tropical and subtropical areas, which have warm bodies of water with high carbonate/bicarbonate concentration, increased pH, and salinity, that are ideal for its growth. Additionally, it can be found in soil, brackish water, freshwater, lakes, marshes, ponds, seawater, and thermal springs.[1] Spirulina grows best in water that is alkaline, salty (>30 g/L), high in pH (8.5-11.0), and temperature between 30 to 35°C, where there is a lot of solar radiation at altitude. Since spirulina is an obligate photoautotroph, it cannot thrive on substrates containing organic carbon molecules in the dark. It mostly assimilates nitrates and decreases carbon dioxide in the presence of light. Spirulina is an obligate photoautotroph thus it cannot grow in the dark on media containing organic carbon compounds. Among the different species of Spirulina genus, mainly two species i.e. *Spirulina platensis (Arthrospira platensis), Spirulina maxima (Arthrospira maxima),* are the most intensively investigated as edible with high nutritional as well as potential therapeutic values. Spirulina refers to the dried biomass of *S. platensis*, occurs in Africa, Asia, and South America, whereas *Arthrospira maxima* are confined to Central America.[6,5] In India, Spirulina cultivation is now being most popular.

Spirulina as a Food Source

The diet or "Aahar" has a specific significance in human health as a way of the good life, health, and well being, according to Ayurveda doctrine. As per Ayurveda texts, the diet known as Mahabhaisjaya, this Sanskrit term that merits consideration for "medicine," refers to the substances that have the ability to have healthy effects on the body, therefore a diet is believed to have health effects beyond just satisfying hunger. Acharya Charak argued that a diet should be followed in order to prevent sickness from developing and to provide the body with the essential nutrients it needs.[7] That's why the idea that prevention is preferable to cure has long been promoted in India. The conclusion is "*Tat cha nityam prayunjeet svasthyam yen anuvartate, Ajaatanam vikaranam anuttpattikaram cha yat.*" (5th Sutra Sthana in Charaka Samhita). This scripture also supported the above Acharya Charaka theory. Another verse reads, "*Pathye sati gadaartasya*

kim aushadh nishevane." Gadaartasya pathye kim aushadh nishevane, which emphasizes the value of a healthy diet. According to this phrase, if whole some food is consumed in a planned manner, there is no need to administer medications. because, in the absence of a healthy diet, this will not be able to cure the sickness.[8]

Based on these principles, a promising nutritional supplement for improving meals is spirulina due to its great supply of proteins, vitamins, minerals, -carotene, fatty acids, and other essential nutrients, making it an ideal food & fodder.[9] It has also an advantage for food security because it can generate protein and energy with less land and water than animals. Spirulina's body has a weak cell wall and a smooth texture, which facilitates easy digestion. Moreover, a protein known as Phycocyanin is a pigment binding, light harvesting pigment obtained from the *S. platensis*, and used extensively as a colorant, food additive, fluorescent dye, cosmetics, and medication.[10,11] Spirulina is consumed in tablet and powder form, and it tastes like grass. Its powder is an extremely adaptable ingredient that may be used in anything that can think of, such as smoothies, baked goods, omelets, and muffins.[12] Likewise, to fortify green tea powder qualities, a mixture of tea and microalgae provide all the essential nutrients.

According to NASA, one kilogram of Spirulina has an equivalent nutritional value to 1,000 kilograms of fruits and vegetables. Scientists in Spain & Japan demonstrated that spirulina extract contains this phycocyanin is a potent water soluble antioxidant. Because of its ecologically sustainable and nutrient rich dietary supplement qualities, spirulina rose to fame after NASA utilized it effectively as a food supplement for astronauts on space missions. Spirulina is being researched as a possible solution for long duration space missions as well as food security and hunger issues. Additionally, it is successfully employed in the fight against malnutrition by WHO, UNICEF, and many African governments. Spirulina has recently been included in the Odisha State Government's Child Nutrition Program in India. Because it is nutrient dense and associated with numerous health advantages, it is regarded as a superfood.

Industrial Application of Spirulina

By industrial application, different varieties of this microalgae (spirulina) are commercially utilized in a variety of industries, including nutraceuticals, food & beverage production, animal feed, cosmetics, perfumery, and agriculture. Moreover, Spirulina is formulated as pharmaceutical products like powder, tablet, capsules, liquid, granules, and gelling agents, etc. Likewise, it is extensively used in the food, beverage, and cosmetic or personal care industries, because it is a huge source of natural edible dye (pigments) that give products their blue colour and can be blended with other colours to create unique new hues. For the production of finished goods, carotenoids, lipids, algal proteins, hydrocolloids, and others are beneficial and in great demand. Therefore, the main factors driving market expansion are a surge in demand for natural ingredients and R & D investments in commercial spirulina products. The government's promotion of spirulina production also promotes market expansion. The initiatives/programs of the Government and/or NGOs to combat malnutrition in undeveloped areas. Further, the global Spirulina market was estimated to be valued at $393.6 million in 2019 and is expected to grow to $897.61 million by 2027 at a CAGR of 10.5%. The major market players by geography are the nations of North America, Europe, Asia-Pacific, and LAMEA. According to Data Bridge Market Research, in the projection period of 2022–2028, the spirulina powder market is projected to increase at a CAGR of 7.90%, from a value of USD 1024.91 million in 2021 to reach USD 1883.03 million by 2029.[13,4,14]

Nutritional value of Spirulina

Nutraceuticals are edibles or food additives that provide supplements to regulate biological functions of living, categorized into nutrients, herbals, dietary supplements, and dietary fibers. Spirulina is nature’s gift as a superfood to mankind and is long held as a highly nutritious food for some decades. The World Health Organization referred to spirulina as "a very suitable food" in 1974 and described it as an interesting food for multiple reasons, is high in protein & iron, and can be given to children without any harm. *Spirulina platensis* has received increasing attention due to its rich source of macro and micronutrients including high quality protein demonstrated by its 70% content and the inclusion of minerals, vitamins, amino acids, and important fatty acids, among other nutrients.[9] So, this rich biomass as well as its primary or secondary metabolites produced by it can be employed as feed and food additives in many industries, science, and medicine.[15] Further, *Spirulina platensis* is the ultimate source for the production of SCP (Single cell protein) and plant based protein. Dried spirulina comprises (see Fig. 1 & Table 1) 60-76% protein, 6-24% carbs, and 4-24% fat, according to the USDA Food Composition Database.[9] It’s a complete

protein source meaning it has all the essential & non-essential amino acids, and essential fatty acids like Alpha-linoleic acid, Gamma-linoleic acid, stearidonic acid, eicosapentaenoic acid arachidonic acid In accordance with the Recommended Dietary Allowance (RDA) one tablespoon of spirulina has Omega-3 and Omega-6 fatty acids, vitamins B1 (thiamin, 11% of RDA), copper (21% RDA), B2 (riboflavin, 15% of RDA), and B3 (niacin, 4% of RDA), iron (11% of RDA), manganese (Mn), potassium (K), and magnesium (Mg). Moreover, simple sugars like glucose, fructose, and sucrose are also minutely present, along with polyols like glycerol, mannitol, and sorbitol.[16]

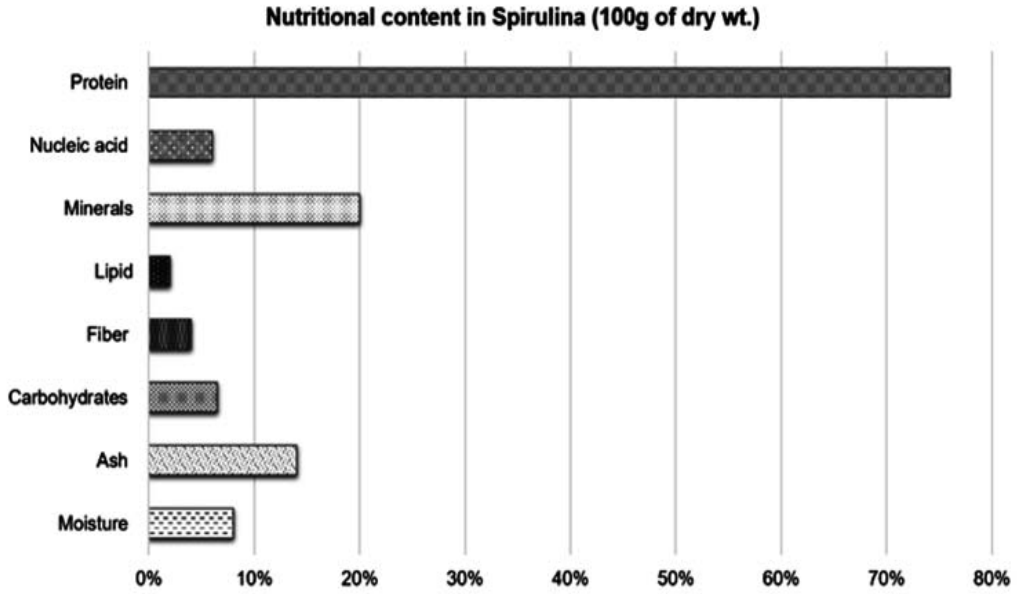

Fig. 1: Chemical composition of Spirulina (100g of dry wt.).

Table 1: Nutritional composition of Spirulina (powder dried weight)

Vitamins Component Content (per 1g dry wt.)		**Minerals Content (per 1g dry wt.)**	
Vitamin B1 (Thiamine)	48 µg	Phycocyanin	180 mg
Vitamin B2 (riboflavin)	55 µg	Chlorophyll	11 mg
Vitamin B3 (Niacin)	0.15 mg	Carotenoids	6 mg
Vitamin B6 (Pyridoxine)	8 µg	Zeaxanthin	1.01 mg
Vitamin B12 (Cyanocobalamin)	2 µg	**Pigments**	
Tocopherol (Vitamin E)	0.41 mg	Phycocyanin	180 mg
Vitamin A (***source*** Beta-carotene)	55 µg	Chlorophyll	11 mg
Pantothenic acid	0.71 mg	Carotenoids	6 mg
Biotin, Folic acid	0.55 mg	**Total carbohydrate content per 100g**	
Inositol acid	0.7mg	Dietary fiber	7.7 gram
Bioflavonoids	10 mg	Sugars	1.3 gram
Vitamin K	2.2 µg	Lactose	< 0.1 gram
Minerals (per 1g dry wt.)		**Essential amino acids (mg/100 g)**	
Potassium (K)	16 mg	Histidine	1000
Calcium (Ca)	15 mg	Isoleucine	3500

table cont...

Phosphorus (P)	10 mg	Leucine	5380
Manganese (Mn)	3 mg	Lysine	2960
Zinc (Zn)	70 mg	Methionine	1170
Magnesium (Mg)	3.7 mg	Phenylalanine	2750
Sodium (Na)	2.5 mg	Threonine	2860
Iron (Fe)	1.7 mg	Tryptophan	1090
Iodine	3.9 mg	Valine	3940

Abbreviations: µg-Micro gram; mg-Milligram; wt.-Weight

Health benefits

As a super food due to its nutrient rich profile, it improves muscle strength & endurance and boosts brain energy as it increases Ribonucleic acid. Scientific studies revealed its capacity of lowering blood sugar levels. Spirulina improves digestive system health. It is good for the heart as it can lower LDL and triglyceride levels as well as inhibition of LDL cholesterol levels in serum.[17,18] Spirulina contains β-carotene as a vitamin A source, important in preventing eye diseases, while iron and vitamin B12 of this useful in treating hypoferric anemia and pernicious anemia. It is effective in the treatment of atopic child eczema therapy because it contains γ-linolenic acid, additionally used in premenstrual syndrome and in immune system stimulation as well as anti-allergic effects by inhibiting the release of histamine.[19] Spirulina was found to be beneficial for eyesight by increasing the serum zeaxanthin level and inhibiting corneal neovascularization. Thus spirulina is a reservoir of active secondary metabolites revealing positive effects against different ailments such as diabetes, hyperlipidemia, inflammatory allergic reactions, metal/chemical induced toxicity, malnutrition, obesity, and anemia. Moreover, a paste of Spirulina is utilized as a face pack, due to its anti-aging characteristics.[20,15]

Pharmacological Activity & their Mechanism

A range of Spirulina derived natural compounds have been shown to portray crucial biological functions, revealed from numerous *in vitro and in vivo* studies. This has been accomplished through the use of phytochemical compounds and their bioactivity in drug discovery. The different pharmacological properties of *S. platensis* are critically summarized (see Table 2), which are adapted from a number of cited Scientific Journals.

Table 2: Pharmacological potential & mechanism of Spirulina

Properties	Study Type	Mechanism
Anti-anemic activity	*In vivo* *Clinical*	By elevating Hb level and RBC count in Pb and Cd induced anemia of rats.[21] Moreover, by raising the level of mean capsular hemoglobin (MCH), corpuscular volume (MCV), and MCHC) in rabbits. It ameliorates anemia in subjects.[22]
Antibacterial activity	*In vitro*	A predominant fatty acid compound from the extract inhibited Staphylococcus aureus MTCC-96, and Salmonella *typhimurium* MTCC-98.[23] Similar activity was observed against human food borne pathogens.[24]
Anti-cancer effects	*In vivo*	The C-phycocyanin pigment from Spirulina was found to be a selective inhibitor against cyclooxygenase-2 (Cox-1), Cox-2, and MCF-7 human breast cancer cells.[15]
	In vitro	Additionally, it enhanced the cell nucleus enzyme activity, apoptosis enzymes, DNA repair synthesis, and inhibited the growth of human colon & hepatocellular carcinoma cells (HCC), proliferations etc.[20]
Anti-diabetic/ Hypoglycemic properties	*In vivo* *Clinical*	It increased in concentrations of active cretin hormones, glucagon like peptide1, and glucose dependent insulinotropic polypeptide against streptozocin induced diabetic rats.[25] Similarly, it enhances insulin resistance to reduce blood glucose levels. [26] Spirulina polysaccharides inhibited α-glucosidase for activity.[27] An oral supplementation to 45-60 Yrs. old male diabetic patients showed a significant reduction (P<0.001) in pre-post glucose levels.[18]

table cont...

Antifungal activity	*In vitro*	The different solvent extract inhibited the growth of skin disease-causing pathogens like *Candida albicans, trichophyton rubrum, and Malassezia furfur*.[28]
Anti-genotoxicity	*In vivo*	Spirulina extract was effective against arsenic-induced genotoxicity in *Orechromis niloticus*.[29] Also, accelerated the DNA repair, reduced DNA fragmentation, and had protective effects against cyclophosphamide, cisplatin & urethane.[20]
Anti-inflammatory property	*In vivo*	Reduced beta-glucuronidase activity and increased anti-oxidant enzyme activity in rheumatoid arthritis model of mice.[30] Moreover, it suppressed inflammatory cytokines, by decreasing IL-6, TNF-α, MDA and IL-1β relative to the LPS group.[31]
Anti-oxidant property	*In vitro*	Its C-phycocyanin showed DPPH radical-scavenging activities, similarly in FRAP & Fe2+ chelating potential.[32] Polysaccharides and different products from spirulina showed same capacity.[33]
Antiviral activity	*In vitro*	A pigment allophycocyanin and a sulfated polysaccharide inhibited the replication of numerous viruses such as enterovirus 71, HIV-1, HSV-1, HSV-2, HCMV, 20 and influenza, human cytomegalovirus, herpes simplex, influenza A, measles, mumps respectively.[15, 34]
Anti-nephrotoxicity	*In vivo*	Provide protection against Cd & Cr-induced renal toxicity in Wistar rats.[35] Similarly, against nephrotoxicity induced by cyclosporine A/gamma radiation in rats, on blood markers as and histopathological observations.[36]
Anti-obesity and Weight loss effects	*Clinical*	Inhibited NADPH oxidase and induces insulin resistance, suppresses adipocyte oxidative stress in clinical and preclinical trials.[37, 38]
Heavy Metal Removal potential	*In vivo*	An oral administration of the extract with zinc in patients of chronic arsenic poisoning protected from lead toxicity, and lipid peroxidation serve as an endogenous antioxidant in rats.[39]
Hypolipidemic effects	*In vivo* *Clinical*	The extract regulated the cholesterol and triglyceride levels in rat models.[40] Phycocyanins from this algae showed similar effects.[26] Oral supplementation to 45-60 yrs. old male diabetic patients, increased HDL level.[18]
Hepatoprotective property	*In vivo*	Phycocyanin-rich extract revealed significant protection against paracetamol-induced toxicity in rats.[18] Similar results showed against d-galactosamine-induced model of rats.[42]
Immunomodulatory effects	*In vivo*	Gamma-linolenic acid and phycocyanin from spirulina modulated the immune system, Inhibiting the release of histamine and modulating CD3 & CD20.[43] Moreover, in response to Con A, increased spleen cell development as well as IL-1 and antibody production.[44]
Cytotoxicity	*In vitro*	Spirulina extract had strong cytotoxicity against the HepG2 cell line (IC50 20.56 ± 1.7 µg/mL) followed by MCF7 & Hela cell in a MTT assay.[28]
Neuroprotective property	*In vivo*	Decreases the level of ROS, nitric oxide and lipid peroxidation Improves locomotor activity.[45] Moreover, in an AlCl3-induced Alzheimer's disease rat model, it significantly increased AchE genes, restored the reduced brain neurotransmitters, and improved brain oxidative status.[46]
Probiotic property	*In vitro*	Spirulina promotes the growth of lactic acid-producing bacteria such as Lactococcus lactis, L. casei, L. bulgaricus, L. acidophilusand Streptococcus thermophilus, as well as the extension of vitamin B1.[47, 48]
Wound healing activity	*In vitro*	The extract incorporated in a skin cream, exhibited wound healing effects on the HS2 keratinocyte cell line with the highest cell viability and significant proliferation.[49]

ABBREVIATIONS

HDL - high density lipoprotein; **AchE** - Acetylcholinesterase; **Cd** - Cadmium; **Cox** - Cyclooxygenase; **Cr** - Chromium; DPPH; 2,2-diphenyl-1-picrylhydrazyl; **Hb** - Hemoglobin; **HIV** - human immunodeficiency virus, **HSV** - Herpes Simplex Virus; **HS2** - Hepatic Stem cell type 2; IL-1β- Interleukin-1β; INF-α- interferon alpha; **LPS** - Lipopolysaccharide; **MCF** - Michigan Cancer Foundation-7; **MCH** - Mean Corpuscular Volume; **MCV** - Mean Corpuscular Hemoglobin; **MDA** - Mass Drug Administration; **MTCC** - Microbial Type Culture Collection & Gene Bank; **MTT** - 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl-2H-tetrazolium bromide; **NADPH** - Nicotinamide Adenine Dinucleotide Phosphate; **Pb** - Lead; **RBC** - Red Blood Cell; **ROS** - Reactive Oxygen Species.

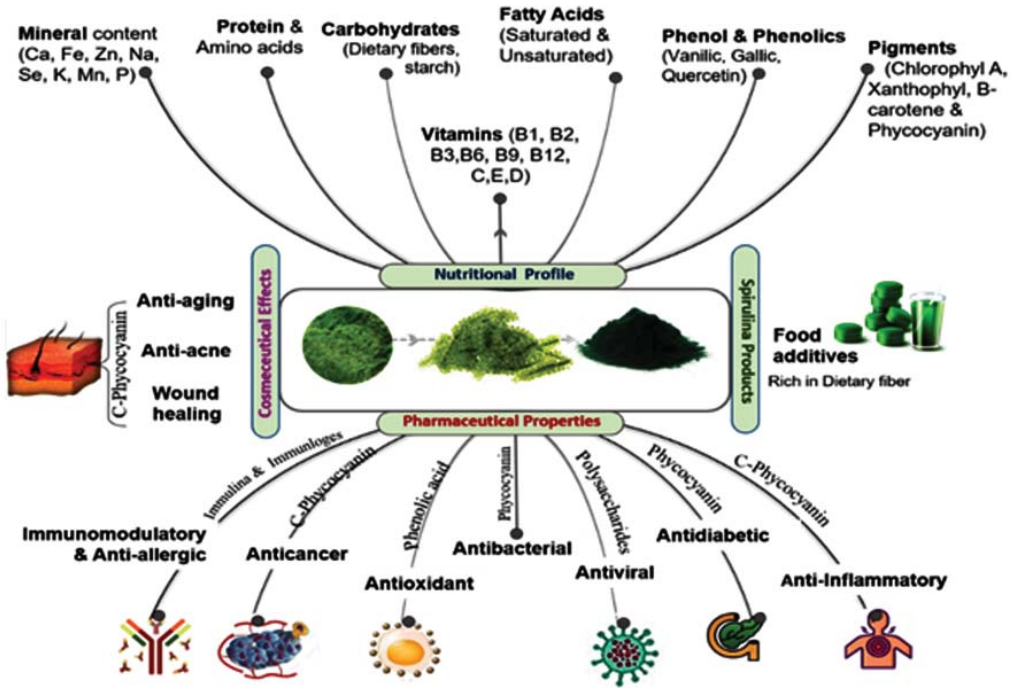

Fig. 2: Graphical illustration of nutraceutical profile & biological properties of Spirulina.

Cosmeceutical Importance

Uses of natural ingredients in the cosmetic industry have been noticed over the last years and similar trends were also observed for marine origin products like spirulina pigments and its metabolites enrich nutra-cosmetic formulations.[50] It is used to fortify the hair, nails, and skin in the form of cream, gel, and mask. Several reports and market claims supported the algae as an anti-aging product for antioxidant, brightening, and anti-acne properties, as well as the natural moisturizing capacity of the amino acids and proteins of algae, is used to the natural moisturizing ability which protects skin cells from drying out. Likewise, other by-products from the algae including terpenoids, pigments, phycobiliproteins (phycocyanin), and lipids (carotenoids, sterols), revealed antioxidant, wound healing, anti-inflammatory, and stabilizing properties in emollients. Moreover, Spirulina is enriched with vitamins that also aid in skin toning, healing dark circles, purifying skin, and encouraging hair growth by inhibiting dandruff.[51,52]

Toxicological Aspects

It is commonly recognized that any organisms or substance must be considered in the safety assessment. For this, it is revealed from *in vivo* experiments that when spirulina or phycocyanin compound was orally given to rats for 14 weeks at a concentration of up to 5% in the diet, the rats did not exhibit any harmful effects. Interestingly, Spirulina has not yet demonstrated any toxicity on the liver, kidney, reproductive system, and body physiology, during and after acute or chronic doses, at higher doses than any anticipated human consumption.[53,54] Although, even at high doses, it seems to be safe, so, it may be used as a source of single cell protein for humans without risk. However, it might also be contaminated through other chemical hazards or metals as per their source of origin. Therefore, it is important to have assurance about the spirulina source or marketed brands. Furthermore, women who are expecting or nursing should follow their doctor's recommendations about the same.

CONCLUSION

Spirulina is already a well known nutritional supplement to fulfill the nutritional requirement of the increasing population. This is supported by information on Spirulina's nutritional worth and biological processes, making it a healthy choice for diet planning, fighting malnutrition, and/or therapeutic uses. Preclinical and post-clinical research is continuously being conducted to determine the bioactive potentials of spirulina. However, these studies appear to show that Spirulina has potent pharmacological effects, which

has increased interest in it as a therapeutic diet. This review provides updated detailed information about the bioactive constituents and nutraceutical importance along with the scientifically claimed medicinal uses of Spirulina. Moreover, given everything stated above, can be concluded that Spirulina has a variety of benefits, including high biological importance, availability of nutrients, ease of cultivation due to minimal growth requirements, and safety in terms of consumption (no toxicities), to mention a few. More studies are hardly needed to support its claimed benefits. Additional prospects for the growth of the spirulina market will arise from the expansion of public and private efforts supporting aquaculture research and development as well as consumer well being awareness.

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Conflict of Interest: (a21) No any conflict

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