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Contents

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Scientific Approach of Food and Nutrition Using Discriminant Analysis for Leading Fit Life

Sangeeta Ahuja

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Abstract

The health of the person is the most import assets in life. Majority of the people in this world ignoring this fact knowingly which leads to make them their life cumbersome. The person who is mentally and physically healthy wisely takes the decisions in his life. The health and fitness of body depends upon the nutrition, calories utilization and life style adaptability. The body needs the balance combinations of nutrients and diet should be balanced accordingly.

In this study the scientific approach of fit body using the statistical, engineering and psychological methods have been utilized which leads to fit life. The computation of BMI, PFI and UCB with NDS have been done. Rigorous experimentation have been done using different data sets and it gives amazing results by diagnosis fit and unfit and the appropriate plan have been suggested accordingly.

Keywords: Food, Nutrition; Fit body; Nutrients; Discriminant Analysis; BMI; PFI.

Introduction

Our body needs different kinds of food for some special purpose. Each food item usually made up of one or more ingredients which we get from plants and animals. These ingredients contain some components that are needed by our body. These components are called as nutrients. The major nutrients in the food are named carbohydrates, proteins, fats, vitamins and minerals.

In addition, food contains dietary fibres and water which are also needed by our body. Is the food contains all the nutrients, is the immediate question, comes into the mind. With some simple methods we can test whether cooked food or a raw ingredient contains one or more of these nutrients. The test for presence of carbohydrates, proteins and fats are simpler to do as compared to the test of other nutrients.

The main carbohydrates found in our food are in the form of starch and sugars. For testing the starch, take a small amount of food item or raw ingredient and put 2–3 drops of dilute iodine solution on it. If it turns blue –black, indicates that it contains starch. Similarly, for testing the protein, make a paste of it, if solid by adding water then add few drops of solution of copper sulphate and 10 drops of solution of caustic soda. If it turns violet indicates the presence of protein. For testing the fat, take a small quantity of food item wrap into a piece of

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paper and crush it. If the paper is having the oily patch it shows the fat presence. All the nutrients not present in all food items. Except carbohydrates, fats, proteins, vitamins the minerals and water are also present in various food items.

Carbohydrates mainly provide energy to our body. Fats also give us energy compared to same amount of carbohydrates. Fats and carbohydrates are called as 'energy giving foods'. Proteins are needed for the growth and repair of our body. Protein are often called as body building food. Vitamins help in protecting our body against diseases. Vitamins also help in keeping our eyes, bones, teeth and gums healthy. Vitamins are of different types Vitamin A, Vitamin C, Vitamin D, Vitamin K and Vitamin B Complex. Vitamin A keeps our skin and eyes healthy. Vitamin C helps body to fight against many diseases. Vitamin D helps our body to use Calcium for bones and teeth.

Besides these nutrients, as said earlier also that our body needs dietary fibres and water. Dietary fibres are also called as Roughage. Roughage does not provide any nutrient to our body but is an essential component of our body. This helps our body get rid of undigested food. Water helps our body to absorb nutrients from food. It also helps in throwing out some wastes from body as urine and sweat. The food normally eaten by human being is the diet.

Methodology

Discriminant Analysis

Discriminant Analysis is a statistical method[7] to separate between distinct classes in multivariate data. It establishes relationships between attributes for classifying objects into one of the several populations, by identifying attributes that best discriminate between the members of the group. In this method, one can judge the maximum discrimination of the object to the specific group through the discriminant score.

For growth and maintenance of good health, our diet should have all the nutrients that our body needs, in right quantities. Such a diet is called the balance diet.

Deficiency of one or more nutrients can cause disorders in our body. Diseases that occurs due to lack of nutrients over a long period are called deficiency diseases (Table 1).

Table 1: Nutrients Deficiency

Vitamins/ Mineral	Deficiency disease /disorder	Symptoms
Vitamins A	Loss of Vision	Poor vision, loss of vision in darkness, sometimes complete loss of vision
Vitamins B	Beriberi	Weak muscles and very little energy to work
Vitamins C	Scurvy	Bleeding gums, wounds take longer time to heal
Vitamins D	Rickets	Bones becomes soft and bent
Calcium	Bone and tooth decay	Week bones, tooth decay
Iodine	Goiter	Neck appear swollen mental disability in children
Iron	Anaemia	Weakness

Basal Metabolic Index (BMI)

The body composition analysis defines for Basal Metabolic Index. This is the energy utilized by the individual to carry on vital body functions when at rest. Body Mass Index[6] was derived by measuring weight and height of the individual using the following formula (Table 2)

$$BMI = \text{Weight (kg)}/\text{Height}^2\text{ (m)}$$

Table 2: BMI Table

BMI Range	Presumptive diagnosis
<16.0	CED Grade III (Severe)
16.0–17.0	CED Grade II (Moderate)
17.0–18.5	CED Grade I (Mild)
18.5–20.0	Low weight normal
20.0–25.0	Normal
25.0–30.0	Obese Grade I

Physical Fitness Index (PFI)

The physical fitness is a term which denotes individual's ability to accomplish a given task in a given time period. The person should be healthy and should not have respiratory problems, and should be given at least 15 minutes of rest before the start of measurement. Physical fitness[4,5] is the state of health of individual, to calculate PFI, the person were asked to perform the exercise for 5 minute, then the heart rate (HR), at the end of I, II and III minute of recovery and then PFI is assessed by using the following equation:

PFI= (Duration of activity/2(sum of I, II and III minute of recovery of HR)) * 100

Respondents ranked from poor to excellent on the basis of PFI as follows in Table 3.

Table 3: PFI Values

PFI grade	PFI range
Poor physical	≤80
Low average fitness	81–100
High average fitness	101–115
Good fitness	116–135
Very good fitness	136–150
Excellent fitness	Beyond 150

Experimentation

Rigorous experimentation[1-3] with survey analysis have been conducted by collected the data by considering various parameters and attributes.

To achieve the fit life though the fit body is done by discriminant analysis[7] by taking all the parameters into consideration. The measurement of the BMI, PFI and NDS (Nutrients Deficiency Syndrome) have been obtained. The above method is the scientific method to be fit after diagnosis by utilizing the above methods into various categories of fit and unfit. If the person is fit he/she maintains the healthy status and if the person is unfit according to this method he has to overcome by keeping fit by adapting the suggestions given in this study (Fig. 1).

The persons who are having fit body i.e. healthy body leading the fit life. Those by this method got the unfit status due to inappropriate life style and unbalanced calorie balance (UCB). They are advised and suggested to intake the calorie requirement as needed and prescribed according to their body fitness status for achieving the fit body and fit life (Fig. 2).

To determine the amount of calories you need to achieve a fit body need to maintain the normal weight. For this the assessment of daily activities and lifestyle also matters.

Total Calories = BMI + Life Style + Activity

In order to maintain normal weight one has to balance the required calories per day and balance theUnbalanced Calories Balance (UCB).

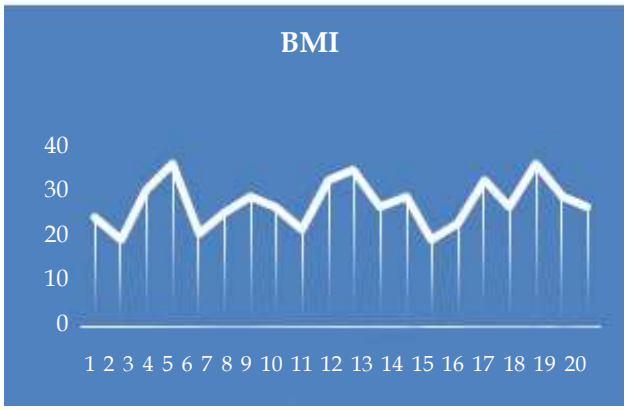

Fig. 1: BMI Measures

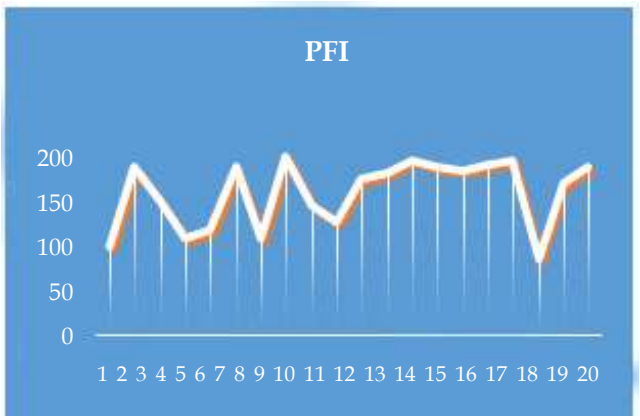

Fig. 2: PFI Measures

One should never skip a meal. Doing so will reduce BMR, making the person inactivate. The person will tend to over eat at the next meal. Instead, have smaller more frequent meals at regular intervals (Fig. 4).

Always have breakfast as it is the most important meal of the day when the nutrient requirements are the highest and a proper breakfast will energize throughout the day. Don't fall asleep soon after the dinner as sleep slows down the body's metabolism and one tend to burn fewer calories and accumulate fat. Instead have a light and early dinner and give yourself a 2 to 3 hours gap before going to bed. Activity patterns also matters. Diet completed with physical activity is better for managing weight and fro better health (Table 4).

The energy utilization for certain activities are listed below.

Table 4: Activity Utilization

Activity	Calories
Jogging or running for 1 Hour	600 Kcal
Cycling for 1 hour	450 Kcal
Tennis or any game	350 Kcal
Walking for 1 hour	180 Kcal

Besides calorie expenditure, physical activity contributes to the total health status of the individual.

Whatever your age, whatever your level of fitness walking is the simplest and most effective form of activity. Regular walks will slowly improve your heartbeat, endurance and all-round level of fitness. Calorie requirements for different age groups are as follows (Table 5)

Table 5: Calories Requirements

Groups	Cal Req. (Kcal)
Men (Sedentary)	2425
Woman (Sedentary)	1875
Woman (lactating)	
0–6 months	2425
6–12 months	2275
Boys (16–18 years)	2640
Girls(16–18 years)	2060

Conclusion

The fitness of body and mind leads to fit life. Majority of the healthy people in this world are happy because they can give the best to their work. The karma is the most important as written in all religious holy books. If one is doing karma and psychologically a kind of work satisfaction comes or urge to do more work also arises. Through work if he is earning and enjoying the luxurious life or spending the money for charity that also gives a

kind of happiness. So in reality everything is correlated. Even in the age of artificial intelligence where the robots work like humans, human should have that nerve cells and brain to think and develop the robots so,in turn, health is not the issue to be ignored. With balanced diet, life style with balanced nutrient utilization the person can reach the optimum of success and happiness. This way not only the body, mind but also the soul will be happy.

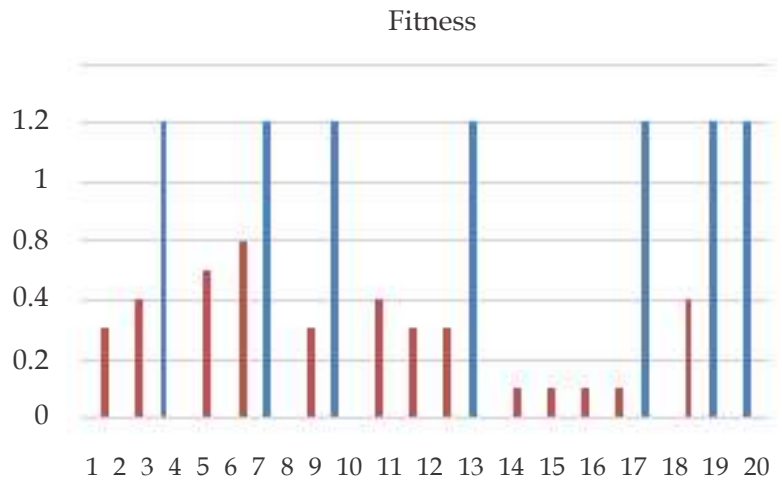

Fig. 3: Fitness Measures

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It is health that is real wealth and not pieces of gold and silver""
– Mahatma Gandhi

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Low Glycaemic Index Snacks Formulation for Diabetics

Lahade Kalpana N[1], Nalwade Vijaya M[2]

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Abstract

The investigation was undertaken to develop low glycaemic index snacks namely *Lentflax* mix and *khastapuri* utilizing wheat flour, barnyard millets flour, bengal gram dal flour, drumstick leaves powder, lentil, groundnuts, flax seeds, gingelly seeds, coriander and omum. Acceptability of the developed snacks was studied. Result of organoleptic evaluation indicated that *Lentflax* mix (8.8) and *khastapuri* (8.3) secured scores for overall acceptability. Nutrient analysis indicated that Lentflax mix and Khastapuri developed snacks were rich in protein and fiber content. Blood glucose response of developed snacks was studied among normal subjects and glycaemic index was calculated. Glycaemic index of *Lentflax* mix was 34.8 and *khastapuri* was 31.3. Even after sixty days of storage both the products were well accepted and microbial level found to be below detectable (BDL) level. Hence these low glycaemic index snacks may be suggested for the consumption by the diabetic subjects.

Keywords: Low glycaemic index snacks; Sensory evaluation; Nutrient and Microbial evaluation.

Introduction

Diabetes Mellitus is the most common metabolic disorder affecting humankind and creating health hazards. According to International Diabetes Federation estimates, around 415 million people had Diabetes Mellitus in 2015 and this number is expected to rise to 642 million by 2040. Diabetes is an increasing problem among urban as well as in rural population (Hwang 2012)[6]. India is home to 69.1 million people with diabetes mellitus and is estimated to have the second highest number of cases of diabetes mellitus in the world after China in 2015 (IDF 2016)[7].

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Low glycaemic index foods, by virtue of their slow digestion and absorption, produce gradual rises in blood sugar and insulin levels, and have proven benefits for health. They have benefits for weight control because they help control appetite and delay hunger. Various researches have proved that low glycaemic index foods control blood glucose levels and effectively manage diabetes. (Silambuselvi and Hemamalini 2016)[8].

Snacks are foods consumed between meals. In today's hectic lifestyle, meals are often taken on the run, between classes, in the car and on the work desk. Snack foods have become part of everybody's life, and often consumed in place of regular meals. Snacks and light meals are popular forms of catering at any time of the day or night and there is a wide variety of foods to be offered (Foskett *et al.,* 2004)[4]. In this contest low glycaemic snacks will be beneficial for prevention, maintenance and treatment of diabetes. Therefore, an attempt was made to develop such snacks which may be useful for consumption of diabetics.

Materials and Methods

Twelve normal randomly selected subjects those willing to serve as experimental subjects were

selected for experiment. The measurements were taken for height (cm) and weight (kg) and body mass index was calculated for selected subjects.

Preparation of snacks: The present study was conducted to develop low glycaemic index snacks. *Lentflax mix* and *khastapuri* these two snacks were developed utilizing wheat flour, barnyard millet flour, bengal gram dal flour, drumstick leaves powder, lentil, groundnuts, flax seeds, gingelly seeds, cumin seeds, coriander seeds, omum,cooking oil and salt. The composition of developed low glycaemic index snacks is given in (Table 1).

Sensory evaluation: The developed snacks were evaluated for different sensory attributes by panel member of 10 semi-trained judges using a nine-point hedonic scale (Amerine *et.al.*,1965).

Nutritional Evaluation of formulated snacks: The parameters analysed were moisture, total minerals, total fat, dietary fiber, by AOAC procedures (1990). The crude protein content was evaluated by micro K-jeldhal method while crude fat was estimated by Soxhlet method. The minerals i.e., iron, manganese, copper and zinc were estimated by atomic absorption spectrophotometer, Perkin R. Elmer Model – 3110. The values of carbohydrate and energy were calculated by using the food composition tables (Gopalan *et al.,* 2010)[5].

Glycaemic index evaluation: Each developed snack was evaluated individually in twelve subjects. Blood glucose response technique was employed to evaluate the glycaemic index of glucose and each test food. Weighted amount of developed test foods providing 50 g of carbohydrate was served to the subject around 7.30 am. Then finger prick samples of blood were collected with lancet at 0, 30, 60, 90 and 120 minutes. Glucose content in the blood was determined by Glucometer. In the same way glucose response in the blood of the subjects was also determined by administering 50g of glucose. Using the blood glucose tolerance curve and food tolerance curve the glycaemic index of the test food was calculated using the formula given by Woleven and Jenkins (1981).

Shelf Life Study: The shelf life of the best accepted snacks was studied. It was packed in polythene pouch and stored at room temperature and refrigeration temperature for a period of 2 months. The samples were drawn fortnightly for assessing the quality by organoleptic evaluation.

Microbial Evaluation: Total bacterial count and presence of yeast and mould at the initial and final day of storage period were analysed by Direct Method of Counting (DMC) given by Dubey and Maheshwari (2004)[3].

Statistical Analysis: To analyse the data't' test and analysis of variance (ANOVA) were used to compare the differences in organoleptic scores of products. The statistical analysis was carried out by following the procedures prescribed by Panse and Sukhatme(1985)[11].

Results and Discussion

A total sample of twelve normal subjects comprised of six male and six females from 30 to 40 years of age group were selected for the experiment. Anthropometric measurements of the selected subjects are given in Table 2. The height of the selected male and female subjects ranged from 151 to 170 cm and 149 to 155 cm with an average

Table 1: Composition of the developed low glycaemic index snacks

Sr. no.	Ingredients (g)	*Lentflax mix*	*Khastapuri*
1.	Wheat flour	-	38
2.	Barnyard millet flour	-	22
3.	Bengal gram dal flour	-	20
4.	Lentil	38	-
5.	Groundnuts	12	-
6.	Flaxseeds	25	-
7.	Gingelly seeds	7	-
8.	Cumin seeds	1	-
9.	Coriander	1	-
10.	Omum	-	0.5
11.	Drumstick leaves powder	-	1.5
12.	Cooking oil	16	18

value 169 ± 0.89 cm and 151.5 ± 2.58 cm respectively. The mean value of body weight of the selected male subjects was 66 ± 2.19 kg and it was ranged from 55 to72 kg. Whereas for female subjects it ranged from 50 to 56 kg with the mean value of 52.5 ± 2.94 kg. Average value of the body mass index of male subjects was 24.83 and 23.0 for female subjects.

Mean values of organoleptic scores for the acceptability of the developed low glycaemic index snacks are presented in Table 3. Results indicated that *Lentflax mix* obtained the highest score (8.5 ± 0.51) for overall acceptability followed by *khastapuri* (8.4 ± 0.59). On the whole both the products found to have good acceptability as the scores obtained for organoleptic characteristics were more than 8.0.

The nutrient content of developed snacks are presented in Table 4. The mean value of moisture (g%), protein (g%), fat (g%), fiber (g%), iron (mg%), copper (mg%), manganese (mg%) and zinc (mg%) of *Lentflax mix* were 3.14, 18.97, 38.82, 2.89 3.15, 1.04, 1.98 and 2.09 respectively. The respective values for corresponding nutrients of *khastapuri* were 5.7, 10.68, 23.04, 3.93, 2.90, 0.46, 0.37 and 1.74. Calculated value of carbohydrate (g) and energy (kcal) of *Lentflax mix* and *khastapuri* was 52.95, 51.47 and 520, 458 respectively. In conclusion the results indicated that both the developed snacks were rich in protein and fiber content. Development of cereal pulse-based value added nutritious instant mixes studied by Lohekar (2014)[10] also reported all most same amount of nutrient content.

The mean values of blood glucose response in normal subjects at 0, ½, 1, ½ and 2 hours after the intake of the test food was studied (Table 5). From the results it is evident that the blood glucose was at the highest peak at half an hour following the ingestion of the food for both *Lentflax mix* (100.38 ± 7.24) and *Khastapuri* (109.5 ± 10.11). There after the level of the blood glucose found to be declined gradually. On the whole blood glucose response values for developed snacks were ranging from 94.08 ± 7.78 to 93.16 ± 7.22.

Table 2: Mean values of anthropometric measurements of selected subjects

Anthropometric measurements	Men (N=6)		Women (N=6)		't' value
	Range	Mean ± SD	Range	Mean±SD	
Height (cm)	151-170	169 ± 0.89	149-155	151.5 ± 2.58	11.05**
Weight (kg)	55-72	66 ± 2.19	50-56	52.5 ± 2.94	14.73**
BMI	22.5-24.5	24.83 ± 2.48	22.2-23.8	23 ± 0.57	14.48**

** Significant at 1 per cent level

Table 3: Mean scores of organoleptic characteristics for the acceptability of developed snacks

Products	Mean value of organoleptic scores of developed snacks				
	Colour	Texture	Taste	Flavour	Overall acceptability
Lentflax mix	8.1 ± 0.55	8.8 ± 0.41	8.4 ± 0.50	9.0 ± 0	8.5 ± 0.51
Khastapuri	8.0 ± 0.72	8.4 ± 0.50	8.0 ± 0.56	8.8 ± 0.41	8.4 ± 0.59

Table 4: Proximate and mineral composition of developed snacks

Nutrients	*Lentflax* mix (Mean ± SD)	*Khastapuri* (Mean ± SD)
Moisture (g)	3.14 ± 0.02	5.7 ± 0.15
Protein(g)	19 ± 0.03	10.68 ± 0.04
Fat (g)	38.82 ± 0.01	23.04 ± 0.62
Fiber (g)	2.89 ± 0.01	3.93 ± 0.02
Carbohydrate (g)	53.0	51.5
Energy (kcal)	520	458
Iron (mg)	3.15 ± 0.02	2.90 ± 0.43
Copper (mg)	1.04 ± 0.02	0.46 ± 2.30
Manganese (mg)	1.98 ± 0.03	0.37 ± 0.61
Zinc (mg)	2.07 ± 0.02	1.74 ± 0.02

The glycaemic index of developed snacks in the normal subjects is given in Table 6. The results indicated that glycaemic index value of *Lentflax mix* and *khastapuri* was found to be 34.8 and 31.3. Significant difference in the glycaemic index of *Lentflax mix* and *khastapuri* was noticed. In conclusion it can be said that both the products recorded low glycamic index value. A study conducted on development and evaluation of Khakhra using low glycaemic index in gredients by Sugantha and Raajeswari (2013)[13] indicated 56.8 value of glycaemic index for Khakhra which is more than found in developed snacks. On the other hand, *Heartdiabocare* functional snack developed by shinde (2018) had 26.77 low glycemic index.

The Mean score for overall acceptability of *Lentflax mix* stored in refrigerator and at room temperature for varying period are presented in the Table 7. The mean scores of overall acceptability of *lentflex mix* stored for varying period at room temperature were ranging from 8.5 to 7.35 and at refrigerator temperature from 8.5 to 7.8. It was found that as the period of storage increased mean score of overall acceptability was significantly decreased. Though the score reduced, it was in the category of like moderately (7.0) in both the samples. From the results it can be inferred that *Lentflax mix* can be stored up to 60 days in an air tight container at room and refrigerator temperature. Even *Heartdiabocare* functional snack developed by shinde (2018) found to be in good condition after a period of 90 days storage.

The mean score for overall acceptability of *khastapuri* stored in refrigerator and at room

Table 5: Mean blood glucose response values of formulated snacks in the selected normal subjects

Particular	Blood glucose response values Mean ± SD (mg/100 ml)				
	0 hrs.	½ hrs.	1 hrs.	1½ hrs.	2 hrs.
Glucose	94.83 ±5.11	149 ± 34.7	125.33 ±15.0	113.33 ± 17.7	100.41 ± 18.87
Lentflax mix	95.41 ± 3.42	100.33 ± 7.24	95.66 ± 4.53	93.00 ± 7.56	94.08 ± 7.78
Khastapuri	95.16 ± 4.87	109.5 ± 10.11	104.58 ± 12.48	100.08 ± 12.34	93.16 ± 7.22
CD	–	–	8.94	9.23	9.44
SE ±	–	–	3.03	3.03	3.04
F- value	NS	NS	5.88**	12**	5.60**

NS - Non-Significant ** - Significant at 1 per cent level

Table 6: Mean glycaemic index values of developed snacks

Name of the snacks	Glycaemic index (%)
Lentflax mix	34.8
Khastapuri	31.3
CD	11.75
SE±	3.9
F- value	13.90**

** - Significant at 1 per cent level

Table 7: Mean scores for overall acceptability of Lentflax mix stored at room temperature and at refrigerator temperature for varying periods

S. No.	Storage period	Mean scores of overall acceptability for Lentflax mix	
		Room temperature Mean	Refrigerator temperature Mean
1	Initial	8.5	8.5
2	15 days	8.1	8.3
3	30 days	8.0	8.0
4	45 days	7.75	7.9
5	60 days	7.35	7.8
	CD	0.40	0.40
	SE ±	0.14	0.14
	F-value	8.83**	4.01**

**- significant at 1 % level

Table 8: Mean scores for overall acceptability of khastapuri stored at room temperature and at refrigerator temperature for varying period

S. No.	Storage period	Mean scores of overall acceptability of *Khastapuri*	
		Room temperature Mean	Refrigerator temperature Mean
1	Initial	8.4	8.4
2	15 days	8.4	8.4
3	30 days	8.2	8.2
4	45 days	7.9	8.0
5	60 days	7.7	7.8
	CD	0.40	0.31
	SE ±	0.14	0.11
	F-value	4.25**	6.20**

**- significant at 1 % level

Table 9: Microbial content of developed snacks

Name of product	Bacterial count				Yeast and mould count			
	Room Temperature		Refrigeration Temperature		Room Temperature		Refrigeration Temperature	
	Initial	2 months	Initial	2 months	Initial	2 months	Initial	2 months
Lentflax mix	2.9×10^{-4}	3.89×10^{-4}	2.9×10^{-4}	3.62×10^{-4}	Nil	Nil	Nil	Nil
Khastapuri	2.64×10^{-4}	3.59×10^{-4}	2.64×10^{-4}	3.33×10^{-4}	Nil	Nil	Nil	Nil

temperature for varying period are presented in the (Table 8). Result indicated that a significant decline in the overall acceptability score of *Khastapuri from* initial to 60th day of storage at room temperature and at refrigerator temperature was noticed. However, *khastapuri* was well accepted up to 60 days of storage period as it scored more than 7.0 for overall acceptability.

The Microbial analysis was done for total bacterial count for the developed snacks at initial and on 60th day of storage period at the refrigerator and at room temperature conditions (Table 9). It was observed that the lowest bacterial count was in *Khastapuri* (3.33×10^{-4} cfu) stored at refrigeration temperature and the highest bacterial count was observed in *Lentflax mix* stored at room temperature (3.89×10^{-4}cfu). Though there was increase in bacterial count of stored sample, it did not exceed the safe level for consumption. On the other hand, the yeast and mould count were not noticed. The results are in line of the study conducted by Langote (2017)[9] on formulation of snacks with incorporation of maize flour and its safety aspects.

Conclusion

On the whole, results indicated that developed *Lentflax mix* and *Khastapuri* had good acceptability. Glycaemic index value of *Lentflax mix* and *Khastapuri was* 34.8 and 31.3 and it can be stored up to 60 days. Therefore, it may be suggested for the consumption by the diabetic subjects as these were found to have low glycaemic index values.

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Review Article

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Nutrimental and Ethnomedicinal Potential Plants of the Qur'an: An overview - II

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Abstract

Our ancient literatures of Hindus', Muslims as well as of Cristian's are full of plants described about their nutrimental and medicinal potential. A significant number of plants described in their texts are still unidentified because of least or no interest in plant taxonomy among neither grate scientists in well-developed different organisations nor respected teachers of Universities or Colleges of repute. We can say with confidence that there are no teachers who can teach Plant Taxonomy in significant numbers of academic institutions. A man of Biotechnology can do nothing if he/she cannot identify the plant on which the work has to be worked out. As a result, due to non-identification of plants we cannot use our wealth of knowledge which has been provided by our ancestors present in form of scripts.

We were presented a book written by Dr. M.I.H. Farooqi entitled "*Quruani Poudhe-Vagayanic Dhristi Se*" while in Seminar organised by UP Biodiversity Board, Lucknow. We found that there are seventy-one plants being reported in Holy Qur'an and Bible. We have consulted the literatures available as well as the tribal of Bahraich about the uses of the plants available. The perusal of the alphabetical list of plants of Holy Qur'an reveals that there are 71 plant species representing 48 genera of 30 families. *Brassicaceae, Cucurbitaceae* and *Moraceae* family were found to be the biggest family represented by 6 plant species each whereas *Caesalpiniaceae, Papilionoideae* and *Poacea*e with 5 plant species each; *Rosaceae* and *Rhamnaceae* with 4 plant apecies; *Mimosaceae, Liliaceae, Pinaceae, Euphorbiaceae, Oleaceae, Lytharaceae, Lamiaceae* and *Arecaceae* with 2 plant species and rest fourteen species viz., *Malvaceae, Asclepidiaceae, Lauraceae, Bixaceae, Dipterocarpaceae, Juglandaceae, Cuprassaceae, Lecnoraceae, Loranthaceae, Anacardiaceae, Sterculiaceae, Ericaceae, Salvadoraceae, and Vitaceae* is being represented by single plant species each.

Keywords: Qur'an; Nutrimental; Ethnomedicinal; Potential Plants

Introduction

Herbal Medicine is the oldest form of medicine known to mankind. It was the mainstay of many early civilizations and still the most widely practiced form of medicine in the world today.

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Ethnobotany is one of the most interesting themes of economic botany which might have first of all came into the existence probably when earliest man of "stone age" observed the animals mostly the apes and monkeys eating certain plants or plant parts ex. Fruits, leaves and even inflorescences to satisfy their hunger. Therefore, on the basis of plants usage first of all by animals and later on by the human beings the concepts of Ethnobotany and Ethnozoology were evolved, which merged into a common term known as Ethnobiology. However, the term Ethnobotany was first of all used in the last of 19th century by J.W. Harsh Berger (1895) to indicate the interrelationship of plants with aboriginal people or tribal societies [Trivedi and Sharma, 2011][144]. In many parts of the world, wild plants are obtained from forests or wild areas designated for extractive resources and managed

by local communities [Jadhav *et al*., 2011][76]. Wild edible plants provide food quantity as well as medicines [Patale *et al*., 2015][111].

India is one of the twelve mega-biodiversity countries of the World having rich vegetation with a wide variety of plants. As per the 2001 census, the tribal population of India is 8.43 crore, constituting 8.2% of total population of the country [Annual Report, 2005-2006][6]. With enormously diversified ethnic groups and rich biological resources, India represents one of the great emporia of ethnobotanical wealth [Pal, 2000][110]. Even today, trial's and certain local communities in India still collecting and preserving locally available wild and cultivated plant species for their day today life [Mahishi, *et al*., 2005[93] and Ayyanar, *et al*., 2010[7]].

We were presented a book written by Dr. M.I.H. Farooqi entitled "*Quruani Poudhe-Vagayanic Dhristi Se*" while in Seminar organised by UP Biodiversity Board, Lucknow. We found that there are seventy-one plants being reported in Holy Qur'an and Bible. We have consulted the literatures available as well as the tribal of Bahraich about the uses of the plants available. The perusal of the alphabetical list of plants of Holy Qur'an reveals that there are 71 plant species representing 48 genera of 30 families. *Brassicaceae, Cucurbitaceae* and *Moraceae* family were found to be the biggest family represented by 6 plant species each whereas *Caesalpiniaceae*, *Papilionoideae* and *Poaceae* with 5 plant species each; *Rosaceae* and *Rhamnaceae* with 4 plant apecies; *Mimosaceae, Liliaceae, Pinaceae, Euphorbiaceae, Oleaceae, Lytharaceae, Lamiaceae* and *Arecaceae* with 2 plant species and rest fourteen species viz., *Malvaceae, Asclepidiaceae, Lauraceae, Bixaceae, Dipterocarpaceae, Juglandaceae, Cuprassaceae, Lecnoraceae, Loranthaceae, Anacardiaceae, Sterculiaceae, Ericaceae, Salvadoraceae*, and *Vitaceae* is being represented by single plant species each. We have enumerated five plants viz., *Acacia nilotica, Acacia senegal, Acacia seyal, Alhgimaurorum* and *Allium cepa* in detail in first part of the manuscript. Now in this present second part we are enumerating eight plants viz., *Allium sativum, Astragaluhadscendens, Bombax ceiba, Brassica arabica, Brassica juncea, Brassica nigra, Brassica rapa*and *Brassica schimperi.*

Eneumerations

Allium sativum Linn. Galic, Mahaaushadha, Lashunaha, Granjanaha, Aristaha, Mahakandaha, Rasonakaha (Amarkosha, 2001, 228pp) and Ugragandha, Malechakanda, Yavanishta (Garga, Dhanwantri, 1971)[57]. In Quran it is named Fum, and pronounced as Soomiha, (Farooqi, 2004)[49]. Ruhan (Kashmir); Lassan (Panjabi); Lashan (Kumaoni); Naharu (Assami); Roshum (Bengali); Lashan (Gujrati); Belulli, Velluli (Malayalam); Lusoon, Lasun (Marathi); Rasuna (Oria); Shunam or Ullipundu or Vellaippundu (Tamil); Viluli or Velluri,Vellulli-tella-gadda (Tel), Lossun (Konkani), Gokpas (Tibetan). (*Alliaceae*):

Allium has 700 species, 30 are found in India. The region of diversity for *Allium* is said to be Central Asian region, (EsquinasAlcazar, 2004). *Allium cepa* (Onion), *Allium sativum* and *Allium ascalonicum* Linn. (Shallot) are largely cultivated species of India. There are about eleven species of *Allium*being cultivated in different states of North East India viz., *Allium sativum* Linn., *Allium chinense* G. Don, *Allium hookeri*Thw., *Allium cepa* Linn., *Allium rubellum*auct. Non Bieb., *Allium porrum* Linn., *Allium ascalonicum* Linn., *Allium tuberosum* Rottl. Ex Spreng., *Allium wallichii* Kunth, *Allium caesium*schrenk and *Allium scheonoprasum* Linn. (Borborah *et al*., 2014)[14].

The garlic is a perennial plant with narrow leaves and a compound bulb consisting of several small bulb lets or cloves, varying from 10–50 which are enclosed in a thin, white or pinkish sheath. The plant produces both seeds and bulb-lets. All parts of the plant, inflorescence, leaves, cloves have been used from earliest time as a condiment or spice for flavouring soup, sausages and salads and also used in folk-and traditional medicine as it possesses antiseptic and bactericidal properties.

Ethnobotanical Uses

In North East India the species have several local names and different indications of medicinal, and edible uses of different plant parts viz., Nohoru (Mayong circle, Assam) bulb in Leucorrhoea (Kalita and Haque, 2011)[85]; Naharu (Assam) bulb for Roundworms (Hazarika and Pandey, 2010)[69]; Shyamfhrengufu (Barak valley, Assam) bulb for high blood pressure and vegetable (Nath *et al*., 2011)[101] and (Nalberi, Assam) in diabetes (Chakravarty and Kalita, 2012)[20;] Naharu (Assam and Manipur) bulb in Back ache, Lumbago and used as poultice (Nath *et al*., 2011)[101], Diabetes, Blood pressure and gastric disorders (Hazarika *et al*., 2012)[70]; Naharu (Dibru-Saikhuwa, Assam) bulb in Flatulence (Purkayastha *et al*., 2007)[118]; Purunvar (Cacher, Assam) bulb in Gastro Intestinal problem (Nath and Choudhury, 2010)[100] and in Menstrual abnormalities (Deak *et al*., 2011)[32]; Naharu (Golaghat, Assam) bulb in Cough and bronchitis (Barukial and Sarmah, 2011); Naharu (Brahmaputra valley, Assam) Rhizomatous stem in Asthma (Kalita and Deb,

2004)[82]; Lashun (Assam) bulb is employed in Lung congestion, Cough and Bronchitis (Sharma *et al*., 2012)[132]; Rasun (Cachar, Assam) bulb in Body ache (Das *et al*., 2008)[31]; Thingkh (Assam) bulbis used in injuries to remove pus and as vegetable (Singh *et al*., 2011)[135]; Kampunc talab (Majuli river island, Assam) bulb in Fever (Gam and Nath, 2012)[56]; Naharu (Gohpur, Assam) bulb in indigestion of domestic animals (Saikia and Borthakur, 2010)[123]; Nohoru (Sujan, Assam) bulb is consumed as Mod pitha (Deori *et al*., 2007)[33]; Naharu (Lakhimpur, Assam) bulb in Cough (Kalita and Bora, 2008); Kumpuntlap (Dibrugarh, Assam) bulb in Cough (Baruah and Kalita, 2007)[11]; Naharu (Lakhimpur, Assam) Rhizome is used in Allergy (Kalita and Deb, 2006)[83]; Rasun, Rynsun (Meghalaya) bulb and cloves are used in Hypertension, Influenza and as a spice (Ahmed and Borthakur, 2005)[3]; Losun (Arunachal Pradesh) Stem in Lung disorder and Vegetable (Tangjang *et al*., 2011)[139]; Chong, cult (Dehang-Debong, Arunachal Pradesh) leaves and rhizome are used in Bone fracture (Kagyung *et al*., 2010)[81]; Jilap (Arunachal Pradesh) bulb is used in Stomach bloating (Namsa *et al*., 2011)[98]; Jalap (Dehang-Debong, Arunachal Pradesh) Leaves as vegetable and tubers as spice (Rathy *et al*., 2010)[121]; Ziva (Nagaland) bulbs in cough (Shankar and Devella, 2012)[130;] Garlic/Lashing (Nagaland) bulbs are used in Cough and Cold, High blood pressure, Indigestion and to promote flow of urine (Jamir *et al*., 1999)[79]; Lasung, garlic (Kiphire, Nagaland) Corm/ bulb in Constipation, Hypertension, chest pain, back pain and sore throat (Sangtam *et al*., 2012)[127]; Chanam (Bishnupur, Manipur) bulb is employed in Paralysis, Rheumatic complaints, Muscular pain, Piles and Worm problems (Sanglakpam *et al*., 2012)[126].

The earliest use of garlic, in record, dates back to Assyrians about 2100–2200 B.C, when the oldest medical book, was written in cuneiform tablets, which included about 250 plant, animal and mineral drugs used for medicinal purpose in Mesopotamia. This writing was deciphered by R. Campbell Thompson. and was published in 1923 as 'Assyrian Herbal' after 20 yrs. of his work where garlic and onion were in the text. Its ancient name is 'Kitajima' and which was mentioned earlier, in 'Eber's Papyrus., Lewis & Lewis-Elvin (1977) state that it was applied externally in indurations. and in 'Papyrus Harris' it is mentioned and it was one of the offerings made by Ramses IIIrd, about 1047–1087 B.C., to the Gods of Thebes (Saha, 1014)[129].

Garlic is used chiefly in hypertension and arteriosclerosis, flatulence, intestinal catarrh of infectious aetiology and for its anthelmintic action. It is also effective in treating bronchitis and the common cold. It is mostly used for seasoning purpose, Stary & Jirasek (1973)[136] (Saha, 2014)[129].

The trade between Mesopotamia, Egypt and India started about 3000 B.C., during Mohanjodaro period, which is still continued. The sharing of their mutual medicinal knowledge and the trade of herbal drugs, like; cinnamon, ginger, pomegranate, calamus, sandal-wood and evenliquorice, asafoetida was quite common. *Allium sativum* (Garlic) and *Allium cepa* (Onion) was introduced into India during that period. Later, the bulbs as seed were brought and grown. In India, the Arabian traders, known as 'Malachi' and the Greeks, the army men of Alexander the Great, (300 B.C.), attacked India, known as 'Yavans' must have brought and used Garlic in their cooking as a condiment and also as a medicine. Therefore, it wascalled as Malachi Kandi meaning 'the tuber of the Malachi' and later as Yavanishta 'meaning' Liking of the Yvan's'. However, the therapeutic value of the garlic was already recognized since, Hippocrates (460–357 B.C.) prescribed eating garlic in uterine tumours and Bower's manuscript (450 AD) from India recommended garlic in abdominal tumours, Lewis & Lewis-Elvin (1977)[90]. Garlic was also adopted in Ayurvedic system of medicine, in India and so a number of medicines were prepared. Dymock, *et al* (1891)[41] listed the uses of Garlic as follows;

1. Garlic is used as a condiment and medicine by the Hindus. In the Raja Nigh anta it is described under the name of Rosena, and bears many synonyms indicative of its properties, such as Ugra-gandha strong smelling, Mahaushadha 'the great medicine" as it is supposed to be a panacea, Bhuta-ghna, the destroyer of the demons," Lasuna, etc.
2. The Hindus considered it to be a tonic, hot, digestive, aperient, cholagogue, and alterative; useful in cough and phlegmatic affections, fever, swellings, gonorrhoea, piles, leprosy, colic, rheumatism, and worms. During its use the diet should consist of wine, meat, and acidic foods. It is used in Facial paralysis, Hemiplegia, Sciatica, Paraplegia, and Convulsive affections: A decoction of garlic in milk is given in smalldoses in hysteria, flatulence, sciatica, and heart disease. A compound garlic powder called 'Svalparasonapinda', which contains garlic, asafoetida, cumin, rock salt, ginger, long pepper, and black pepper in equal proportions, is given in doses of about twenty grains, every morning with a decoction of the root of the

castor oil plant, in facial paralysis, hemiplegia, sciatica, paraplegia, and convulsive affections.

3. Anti-allergy agent: Garlic juice is applied externally as a counterirritant. However, (Sharma, 1976)[131] has compiled the day to day uses of Garlic in a publication, 'Vaidya Raj Lashun' in which he has listed about 125 day to day uses in diseases and ailments. In Ayurveda the following preparations are prepared and sold in the market;rason-vati, rason-pind, rason-astak, lasunyadighritanly.

Garlic is also used in folk-medicine variously in different parts of the country. D. Souza, 1993, p.269 has mentioned that in Maharashtrain ear-ache and pus in ear, three flakes of garlic taken and boiled in three table spoons of till oil cooled and three drops are put in the year.; in cough and cold 3 flakes are put into one cup of water, which is heated and one cup is taken in the morning and one in the evening; in poor digestion 5 garlic flakes, 2 green chillies and little salt are ground into a paste and then it is fried in 3 teaspoon of till oil and is taken for seven days.

In Quran, Garlic and Onion are well mentioned in Sure II (Baqarah-the Heifer) Verse: 61. It is mentioned that the Prophet did not like its smell and also stated that those who take raw garlic may not come to the Mosque. It is stated that Prophet also recommended Garlic in several diseases, (Farooqi, 2003 & 2004)[48,49].

In Europe it is being used as anthelmintic, diuretic, and also a febrifuge in intermittent fevers. If mixed with salt and oil it heals up amputations and other wounds, In World War Ist this practice was very much used with the wounded soldiers who had lost their limbs. When mixed with honey it is a useful remedy for soft blotches, damp head ulcers, scabies, etc. The juice is used in deaf-ears. Garlic cloves alone or mixed with parsley and olive oil is taken as a remedy to clean the urinary bladder of sand and stoneand is supposed to drive away abdominal swellings.

Indigenous uses

Garlic can easily be placed among the panaceas herbal medicine as it is used in different parts of the world with various uses (Keller, 1978; Foster & Tyler, 2000[55]).

The bulb is used as a vermifuge, diuretic, carminative, expectorant and stimulant. Oil is used for skin rashes, as ear drops, in atonic dyspepsia, flatulence and colic. Decoction of garlic with milk isused in small doses for heart disease.

In Kerala, hypercholesterolemic patients are being advised by their physicians to use 10–15 gms garlic daily. In Indian homes, except for few sects of Hindus, use of garlic in several food preparations as a condiment. The oil in which the garlic-cloves are fried is a popular remedy for ear ache. In some parts of India, ladies, after child birth use garlic in large quantities. It is also used in tooth ache. Thus, the garlic acts as prophylactic in several ailments & diseases.

Parts used

Presently, the cloves from the bulb, dried flowers, clove-dried powder, garlic-salt and its essential oil are used in medicine. The leaves and the cloves are used in culinary and for seasoning purpose.

According to Oliver Bevor (1986, p.256.)[103] the dried flowers of Garlic are used in diabeteswhich has an organic sulphur compounds,the ethyl-ether extract of 58% of dried flower head acts to the standard of tolbutamide, the medicine of diabetes,

Garlic powder

The cloves are dehydrated and powdered. The powder has the same chemical composition and pharmacological activity except it does not have the allicin, the pungent principle. The pungency could also be regenerated by adding fresh enzyme or fresh crushed garlic in small quantity (Pruthi, 1976, p.128)[117].

Garlic salt

It is prepared by mixing 20 parts garlic powder; 78 parts of refined pulverised salt and 2 parts of anti-caking agent (Pruthi, 1976)[117].

Eessential oil

On steam distillation of crushed garlic at atmospheric pressure, the major odour producing principle allicin is decomposed down to diallyl disulphide and other sulphides. This explains, why the volatile oil of garlic consists chiefly of disulphides. However, pure allicin can be isolated by steam distillation at reduced pressure. According to Pruthi (1976)[117] the mother precursor alliin does not possess bactericidal activity. It is only allicin,

which has the bactericidal activity. The inhalation of garlic oil or garlic juice has been recommended in case of pulmonary tuberculosis, rheumatism, sterility and impotency.

Allium sativum is being used by Bhotiya Tribal communities in Niti valley of Central Himalayato cure Carbuncles where five bulbs are ground and mixed with 1 gm salt and made in to paste and applied once a day for continuous seven days [Phondani *etal*., 2010][112].

Allium sativum is being used by Bhotiya Tribal communities in Niti valley of Central Himalaya to cure Paralysis where 5 bulbs are fried in 50 ml mustard oil and filtered. The filtered oil is rubbed on the affected part before sleeping and the same treatment is continuedfor more than 1 year [Phondani *et al*., 2010][112].

Chemical constituents

The chemistry of Garlic has been extensively investigated and the investigations are still continued with the chemistry of complicated transformed sulphur compounds, which are generally not foundin nature, and with the pharmacological and clinical studies. However, the chemical investigation has been reviewed by and the same is represented as below:

The bulb contains the only one sulphur compound known as allin but in presence of allinase enzymes present in the tissue at once transforms it into allicin, which is responsible for the peculiar garlic-smell of the bulb(Raj & Parmar,1978[119] and WHO, 1999)[154].

i. Alliin, (Cysteine sulfoxide) an odourless, non-volatile, crystalline substance having no bactericidal activity and the non-volatile γglutamyl-cysteine peptides, which make up more than 82% of the total sulphur compound contents, of garlic.

ii. As soon as when, the bulb is crushed or cut alliin comes in contact of the enzyme allinase found in the vacuoles of the crushed, cells it reacts with alliin, and hydrolyses and condensed soon it is converted into an oily substance called allicin (WHO, 1999)[154].

iii. Allylsulfenic acid or allyl 2-propenethiosulfonate, which has an irritating odour, it bears the gram-positive and gramnegative bactericidal pharmacological properties. However, the non-volatile γ-glutamyl-cysteine peptides does not react with the enzyme alliinase and remains as such (WHO, 1999)[154].

iv. Allicin is extremely odoriferous pungent with peculiar garlic smell and is unstable product and will undergo additional reaction to form other derivatives or compounds depending on environmental and processing conditions such as; compounds like, E-ajoene, Z-ajoene, and vindyldithiins (2-vinyl-(4H)-1, 3-dithin, 3-vinyl(4H)-1,2 dithin and its. reduced sulfides (diallyl disulfide,diallyltrisulfide), however these are not naturally occurring compounds, (WHO, 1999)[154].

v. Thioglycoside: It is also reported and which is a biologically active component. Garlic also contains glucosinolates in addition to sulphides and Diallyldisulphide and Thioglycoside:

vi. Allicin with combining with vitamin B1 forms allithiamine, which is a stable substance resistant to aneurinase, a vitamin B1 decomposing enzyme produced by several intestinal bacteria. It is quickly absorbed from the intestinal tract and reduced to vitamin B1 in the body. Absorption of vitamin given by mouth is limited, while allithiamine is practically without any limit. Allithiamine gives a garlic odour to the breath as it split into vitamin B1 and allylmeracaptane in the body.

vii. However, thiamine propyl-disulfide in which the allyl radical is replaced with the propyl radical, gives less garlic odour than does allithiamine and thiamine tetrahydrofurfuryldisulfide, and is available also in the market of Japan under the name Alinamin A. It is a odourless and retain the same vitamin B1 activitiy as allithiamine (Takeda Chobu, 1971).

viii. Other known garlic compounds are S-Methyl Cysteine, S-Allylcysteine and S-methyl, S-ethyl, S-Alyl and S-Butyl derivatives of cysteine sulphoxide, S-ethyl-L-Cysteine sulphoxide and S-ButylL-Cysteine sulphoxide.

xi. The skin of garlic contains pectic substances, in addition to proteins, lipids, lignin, mannitol, rhamnose, galactose, and small amount of Arabinose.

x. Other compounds reported are; Alliin homologs, fatty acids such as palmitic, oleic, linoleic and linolenic in addition to polyenoic acid, flavanols, such as glucosides of Kaempferol and Quercetin, in small amount.

xi. The metals are also present such as selenium

0.30 µg/g., Iron varied from 10–20 mg/100 g. absolute dry weight, Copper-0.92 mg/100 g., Aluminium-2.86 mg/100 g.,Crtraces, Nickel-4.2 mg/100 g, Manganese-traces, and Selarium-38.2 mg/100 g.clove wt.

xii. The Garlic young leaves: Young leaves of garlic contain Sulphur amino acids and peptides Cysteine, methionine, S-Allyl-LCysteine sulphoxide, Raj & Parmar (1978)[119].

xiii. The Garlicroots: These contain S-Methyl-L-Cysteine sulphoxide in addition to many unidentified sulphur containing amino compounds.

xiv. The Garlic seeds: The seeds contain; endogenous gibberellins, carbohydrates, like cytokinins andpolysaccharides.

Garlicnins, a new compound

Nohara *et al.,* (2012)[102] has found out several novel sulphides from acetone extracts and identified these and named as garlicinins B1, C1 and D and they have the ability to control macrophage activation, and their structures were also characterised. The mechanism of these sulfoxides' compounds production is also discussed. The discovery of these novel new compounds may open new chemistry to the Allium sulphide and future pharmacological investigations aid the development of natural, healthy foods and anticancer agents that could potentially prevent or combat disease.

Infections and infestations, which includes the antibacterial and antifungal activities of alimentary system and skin

According to Etkin (1981)[46], it contains volatile or essential oil, which contains allicin, which has demonstrated a strong antibacterial activity; salivine accelerate healing of wounds; fungicidal and anti-parasitic activities.

The fresh garlic juice, the essential oil, water and ethanol extractsinhibitthe in vitro and were found to be effective against a number of pathogenic bacteria and fungi such as; *Bacillus* sp.,*Staphylococcus aureus*, *Shigella sonnei, Erwinia carotovora*, *Mycobacterium tuberculosis*, *Escherichia coli*, *Pasteurella multocida*, *Proteus* sp., *Streptococcus faecalis*, *Pseudomonas aeruginosa*, *Candida* sp., *Cryptococcus* sp., *Rhodotorala rubra*, *Torulopsis*sp. *Trichosporon pullulans* and *Aspergillus niger*. As stated earlier, its antimicrobial and antibacterial activity is attributed to allicin. Ajoene and diallyl trisulfide also have the antibacterial and antifungal activities, (WHO, 1999, p21.)[154].

Antibacterial activity of the essential oils

Though, numerous works are available on the antimicrobial activity of the essential oils (EOs) of garlic in vitro but in this study the EOs from *Allium sativum* and *A.porrum* has revealed that it is good against the most dreaded microbes like; *Staphylococcus aureus, Psedomonas aeruginosa, Escherichia coli.* The main constituents of garlic essential oil are; diallyl monosulfide, diallyl disulphide, diallyl trisulfide and diallyl tetrasulfide. It is suggested that the presence of the allyl groups is fundamental for these sulphide derivatives (WHO, 1999, p21.)[154].

Anthelminthic or Anti-worm activity

Garlic has been used in the treatment of the round worm (*Ascaris strongyloides*) and hookworm (*Ancylostoma caninum* and *Necatoramericanus*). Allicin appears to be the active anthelminthic constituent, and diallydisulfide was not found effective., (WHO, 1999.p.21)[154].

In human beings, the oral administration of aqueous extract for 2 months, reduced lipid levels in serum and liver. Both the juice and the essential oil of garlic were found to have significant protective action against fat induced increase in serum cholesterol and plasma fibrinogen and decrease in fibrinolytic activity as well as coagulation time. The aqueous extract reduces the arterial blood pressure in rats,' cats, dogs and human beings. Supplementation of garlic to rabbits fed cholesterol revealed significant lower levels of total, free and ester cholesterol and phospholipids and thus the reduction in the atherosclerosis.

In Lead Poisoning

The Bulgarian preparation 'Satal' has been found to be a drug for treating occupational lead poisoning. In workers suffering from chronic lead poisoning, garlic had a beneficial prophylactic action (Saha, 2014)[129].

Pesticidal Activity

Crude extract and the oil from garlic has shown to be larvicidal in some insects. The larvicidal principle was identified as Diallyl disulphide and Diallyl trisulphide (Saha, 2014)[129].

In modern uses

Generally, in medicine, it is mentioned as a cure for cancer to tuberculosis but mainly mentioned as a cure of;

Atherosclerosis and high blood pressure;

Inhibits or kills a broad range of microbes;

Active against viruses that causes cold & flues

As an expectorant.

Note: Atherosclerosis, a cardiovascular disease in which fatty plaques build up in arteries and obstruct blood flow can be overcome by reducing cholesterol and triglyceride in the blood by consuming raw clove per day.

In nutshell, it has been well established that Garlic is beneficial in;

i. High cholesterol;
ii. Diabetes and blood sugar;
iii. In Yeast infection;
iv. In booting immune system;
v. Increase absorption of iron and zinc.
vi. As an Antioxidant;
vii. In cold & flu;
viii. As an antifungal;
ix. As an antiparasitic; and as an antiallergy.

Anticancer uses of Garlic

In dealing with the monumental work on the plants used against cancer throughout the world from the year 1967 to 1971, Hartwell, (1970, p. 133)[68], conducted a worldwide survey of plants in various literature of the world, which were used in cancer, and he found that both the species of *Allium* viz., *Allium sativum* and *Allium cepa* were used against cancer. Hippocrates had shown that Garlic salve was used in Egypt in indurations of limbs and it was also used in uterus cancer. He had also cited that in India it was used in abdominal and glandular tumours with animal fat and butter.

Recently, a literature survey conducted by Mantle & Wilkin, (2005) reviewed that plants used against cancer, like Mistletoe, Ginseng and Garlic found very promising. It was found that in number of cases of controlled studies it was demonstrated that a protective effect of garlic consumption against human cancers conducted by various workers in different countries is well marked.

Cancer Prevention

In a recent study undertaken by Wang *et al* (2012). demonstrated that Garlic plays a significant role of cancer prevention, but the specific compound and the mechanism is not yet known. In the experiment a study was conducted in which antiproliferative and prop-apoptotic activities of allicin in murine Lymphocyte's (EL-4) and the mechanism of inducing apoptosis (in vitro) was conducted. It was concluded that allicin induced apoptosis in EL-4 cells and in concentration –dependent manner. It is presumed that the mitochondrial pathway might play a central role.

Pharmacological Activities of the Allium sativum

Antidiabetic activity

Allium sativum L. was found to have a hypoglycaemic influence on the fructose induced insulin resistant rats (Jalal *et al*., 2007)[78]. The antidiabetic activity of *A. sativum* L. showed that garlic treated rats had 57% less serum glucose, 40% lower serum cholesterol levels and 35% lower triglycerides compared to the streptozotocin induced diabetic rats. Urinary protein levels in garlic treated diabetic rats were also 50% lower compared to the diabetic controls (Thompson *et al*., 2007).[142]

Antibacterial activity

Freshly prepared infusion of garlic cloves possessed high antibacterial activity against penicillin (Cavallito and Bailey, 1944)[19]. *A. sativum* L. showed broad spectrum antibacterial activity against human pathogenic microorganisms viz. *Salmonella typhi, S. paratyphis, Pseudomonas spp., Staphylococcus aureus, Klebsiella pneumonia, Enterococcus faecalis* and *Klebsiella oxytoca* (Acharya *et al*., 2011)[1]. *A. sativum* L. showed antibacterial activity against *Mycobacterium tuberculosis* (Hannan *et al*., 2011)[65].

Wound healing activity

Allium sativum L. was used as antiseptic to heal wounds during world war II (Essman, 1984)[41].

Antioxidant activity

Antioxidant activity of *A. fistulosum* L., *A. tuberosum*Rottl. ex Spreng. and *A. sativum* L. were reported from liposome model (Yin and Cheng, 1998)[157].

Antimicrobial activity

Allium sativum L. extracts exhibit antimicrobial activity against *Staphylococcus aureus*. The stem extract of *A. fistulosum* L. was more active against *Bacillus sublilis* (Chang *et al*., 2013)[21].

Cytotoxic and anti-tumour activity

Epidemiologic and laboratory studies suggest that *Allium* vegetables and garlic constituents have antitumor effects (Hsing *et al*., 2002)[74].

Antifungal activity

Allium sativum L. showed antifungal properties (Moore and Atkins, 1977)[96].

Discussions & Conclusions

The main scientific claims are

i. It reduces serum cholesterol and triglycerides,
ii. Inhibits platelet aggregation (thins blood) and
iii. Lowers blood pressure.

Presently, so many of experiments have been conducted to verify these claims. According to (Talbot, 2003)[138] the most well-controlled studies have resulted in a lack of beneficial effects In USA the food and Drug Administration has gone so far to issue rulings toprohibit the use of claimfor a relationship between garlic,decreasedserum cholesterol and the risk of cardiovascular disease.

However, the overall conclusion stated by Talbot, 2003[138], dietary supplementation with aged garlic extract has beneficial effects on the lipid profile and blood pressure of moderately hyper-cholesterol emic subjects.

It can be concluded from the comprehensive literature study of the species that the Allium sativum L. species growing are tremendous source of medicinally and economically important plants. They are widely and very popularly used as vegetables and spice. Also, their potentialities against certain disease are proved experimentally during past years. The genus shows powerful anticancer activity with biologically active compounds like Allicin and other sulphur compounds which also give them the peculiar spicy odour. More than the anticancer it also possesses antimicrobial, antifungal, antiviral, analgesic, anti-inflammatory, antioxidant, ant-helminthic and antidiabetic activities. Thus, there is a terrific scope for the use of the phytoconstituents of *Allium sativum* L. species clinically and commercially. For this further scientific and practical exploration with sustainable conservation of the locally available species are necessary to get therapeutic efficacy.

Astragalus adscendens Boiss. & Hausskn. Persian Manna, Gaz khansar Gina Gazi (*Fabaceae*):

Synonyms

Astracantha adscendens (Boiss. & Hausskn.) Podlech; *Astracantha onobrychis* L. *brachycalyx* (Fisch. ex Boiss.) Podl.; *Astracantha eriostyla* (Boiss. & Hausskn.) Podlech; *Astragalus oechtoeranensis* Freyn.; *Astragalus turrillii* Eig.

It is found on Rocky mountain slopes and hillsides, 1700–2500 metres in north Iraq, W. Asia and Turkey in Well drained soil and Full sun. It is common in light (sandy) and medium (loamy) soils, prefers well-drained soil and can grow in nutritionally poor dry soil. It prefers acidic, neutral and alkaline soils. It cannot grow in the shade.

Astragalus adscendens is a spiny, dwarf, deciduous shrub, loosely branched from the base, growing 20–100 cm tall. The species is hermaphrodite and is pollinated by Bees, Lepidoptera (Moths & Butterflies).

Astragalus Linn. (Fabaceae), as the largest genus of vascular plants, contains an estimated number of 3000 species [Safer *et al*., 2014], and nearly 133 in Europe [Pistelli, 2002][87].

Ethnobotanical Potential

This species has a symbiotic relationship with certain soil bacteria, these bacteria form nodules on the roots and fix atmospheric nitrogen. Some of this nitrogen is utilized by the growing plant but some can also be used by other plants growing nearby.

This plant is one of the many species of *Astragalus* that produce tragacanthin gum-a substance with many uses in medicine, as a food additive and in industry. This species produces

only small quantities of a yellow gum, which is not commercially desirable but is used locally.

A source of a poor grade of gum tragacanthin

Gum tragacanthin, obtained mainly from the root, is used in the food industry primarily as a thickening agent, mainly in ice cream, candies, syrups, jellies, salad dressings and mayonnaise. Gum tragacanthin, obtained mainly from the root and stem, has a wide range of applications. The greatest demand comes from the textile industry in which the gum is used as a thickening in the preparation of boiled dyes for calico printing, in the application of textile dyes, for sizing yarns and threads, and in the dressing of silk fabrics and lace. It is also used in the printing trade; in the production of matches; the preparation of plastic materials; glue-making; to supply the gloss in water colours and ink; in perfumery; pencil manufacture, and in the paper industry, as a binding agent.

Cosmetically, it is used in toilet creams, jellies, lotions, dental creams, etc.

It is also used in the production of superior sorts of soap.

It can be used as an agar substitute in the preparation of nutrient media.

Tragacanths are sometimes used as fuel in areas where wood is in short supply.

Ethnomedicinal Potential

Plants of the genus *Astragalus* are of great importance for current medicinal practice [Lysiuk and Darmohray, 2016][92].

Gum tragacanthin is mucilaginous and emulsifier. It is sometimes used as a remedy for coughs.

The gum is more commonly used in the pharmaceutical industry in the making of pills, tablets, and certain medicaments. Its principle medicinal role is as a mucilage to suspend heavy water-insoluble powders such as bismuth or zinc preparations.

Gum tragacanthin contains from 20–30% of a water-soluble fraction called tragacanthin (composed of tragacanthic acid and arabinogalactan). It also contains from 60–70% of a water-insoluble fraction called bassorin. Tragacanthic acid is composed of D-galacturonic acid, D-xylose, L-fructose, D-galactose, and other sugars. Tragacanthin is composed of uranic acid and arabinose; it dissolves in water to form a viscous colloidal solution. Bbassorin swells in water to form a thick gel.

Plants of the genus Astragalus have long been used as medicinal plants in folk medicine of numerous countries as cardiovascular, antihypertensive, diuretic, choleretic, as well as antimicrobial and antiviral remedies.

Resin is used in treatment of diarrhoea and treatment of burns [Habib-allah *et al*., 2016][62].

Bombax ceiba DC.; Shalmali, Semal, Silk cotton tree (*Bombacaceae*).

It is a large deciduous tree. Leaves are digitate, leaflets 5–7, flowers red or yellowish, capsules ovoid. Phenology is March-April.

Ethno-botanical potential

The silk cotton tree is often referred toas the silent doctor for the host of medicinal benefits that is offers almost each part of the tree, including the bark, flowers, fruits, seed and leaves, gums, thornshave therapeutic potential.

An herbal composition made from the bark of the tree, for example is administered for the treatment of male sexual and gastro-intestinal disorders like dysentery and diarrhoea. The pharmacological benefits are basically due to the presence of Glycosides and tannins in the root and stem.

It has haemostatic properties and is administered during menorrhagia.

Ethnomedicinal Potential

Silk cotton extracts are used in eve care, ten tax forte, acne pimple cream. The plant is also being used for general debility, diabetes, impotence, spermatorrhoea, urinary stones and liver disorders.

Some of the diseases for example diarrhoea, dysentery, asthma, rheumatism, leprosy, leucorrhoea, body pain, wounds are included inanti-inflammatory, analgesic, anti-microbial and oxytocic activities of plant as indirect evidence of scientific validation (Jain and Verma, 2014)[77].

Concoction mixed with sugar is drank so as to regulate the menstrual irregularity [Chetri, 2019][24].

Bambax ceiba is employed in treatment of Lantana camara Linn. Poisoning (Bokrey) in cattle [Chetri, 2019][24].

Bambax ceiba is ranked D in DMR of multipurpose uses of medicinal plants which is used as medicine, source of timber, fodder and in anticrafts [Chetri, 2019][24].

Brassica arabica (Fisch. & C.A. Mey.) Fiori (*Brassicaceae*):

The accepted Scientific name of *Brassica arabica*is *Erucastrum arabicum* Fisch. & C.A. Mey.

Synonyms of *Erucastrum arabicum* are *Brassica arabica* (Fisch. & C.A. Mey.) Fiori; *Brassica schimperi* Boiss.; *Diplotaxisinopinata* Sprague; *Sisymbrium abyasinicum* E. Fourn.; *Sism briumhararense* Engl. (GBIF Secretariat, 2017)[58].

The heterotypic synonyms are *Brassica schimeri* Boiss; *Erucastrum arabicum* var *schimoer* (Boiss) O.E. Schutz; *Erucastrum arabicum* var *hararense* (Engl.) O.E. Schutz.; *Sisymbrium Hararense* Engl. (1902); *Diplotaxis inopinata* Sprague (1914) and *Sisymbrium abyasinicum* E. Foum. (SANBI, 2012)[125].

Brassica juncea (L.) Czern. Assamese Lahi, Lai, Jatilai, Lai-sak Beng Rai Sarsapa Leaf mustard, Brown mustard, Mustard greens, Mustard cabbage, Indian mustard, Chinese mustard, Sarshap, Sarson, Kempusasive, Sarshapa, Saasive, Sarshaph, Sassama, Kaduku, Cherukaduku, Sarshapam, Hangam, Mohari, Samsvel, Rai, Leaf Mustard, Brown Mustard, Mustard, Indian Mustard, Sarshapa, Rajika, Katuku, Kadugu, Sarsapamu, Sasuvulu, Sarshaf Brown Mustard (*Brassicaceae*):

This species has been cultivated as a food crop for many hundreds of years and, in that time, several quite distinct forms have arisen. The nomenclature of these forms is confused, to say the least, and by no means universally accepted. We have followed the treatment used by GRIN, though it is very likely to be revised in the future [Ken Fern, 2014][52].

Synonyms

Brassica argyi H. Lév.; *Brassica arvensis* juncea (L.) Kuntze; *Brassica besseriana* Andrz. Ex Trautv.; *Brassica cernua* (Thunb.) Matsum.; *Brassica chenopodiifolia* Sennen & Pau; *Brassica integrifolia* (H.West.) Rupr.; *Brassica japonica* (Thunb.) Siebold ex Miq.; *Brassica juncea japonica* (Thunb.) L.H. Bailey; *Brassica lanceolata* (DC.) Lange; *Brassica napiformis* (Pailleux & Bois) L.H. Bailey; *Brassica richeri* Lange; *Brassica rugosa* (Roxb.) Prain; *Brassica taquetii* H.Lév.; *Brassica willdenovii* Boiss.; *Cruciferajuncea* E.H.L. Krause; *Raphanusjunceus* (L.) Crantz; *Rhamphospermumvolgense* Andrz. ex Rupr.; *Sinabracajuncea* (L.) G.H. Loos; *Sinapisabyssinica*A. Braun; *Sinapisbrassicata* L.; *Sinapis campestris* Jacq. ex Steud.; *Sinapiscernua* Thunb.; *Sinapischinensis* L.; *Sinapiscuneifolia* Roxb.; *Sinapis japonica* Thunb.; *Sinapisjuncea* L.; *Sinapislanceolata* DC.; *Sinapis oleracea* C. Presl; *Sinapispatens* Roxb.; *Sinapisramosa* Roxb.; *Sinapis rugosa* Roxb.; *Sinapissinensis* J.F. Gmel.; *Sinapistenella* Moench; *Sinapistimoriana* DC.

Brassica juncea is an erect, often unbranched annual to biennial plant growing up to 160 cm tall when in flower [Protabase, 2004][116]. It is the parent of several distinct forms that are grown for food, oil etc. Erect annual herbs, about 20–100 cm tall. Rootstock tuberous. Stem sparsely branched. Basal leaves in not rosulate, broadly oblong to oblanceolate, lyrate-pinnatifid, about 6–22 × 2.5–16 cm across, base cuneate, margin shallow dentate, apex obtuse, glabrous or pubescent, petiolate about 2–10 cm long, middle leaves oblong-ovate, upper cauline leaves linear-lanceolate or narrow oblong-oblanceolate, about 2–6 × 0.7–2 cm across, base attenuate or cuneate, margin entire or rarely shallow dentate, petiole sessile. Inflorescence racemes, axillary or terminal, many flowered, elongated in fruit, ebracteate. Flowers bisexual, bright yellow, actinomorphic, pedicel erect, divaricate, slender, sepals 4, oblong, about 4–5 × 1–1.5 mm across, petals 4, spathulate-obovate, base attenuate or caudate, margin entire, apex obtuse or shallow emarginate, about 3–9 × 5–7 mm across, claw about 3–6 mm across. Stamens 6, tetradynamous, filaments about 4–7 mm long, anthers oblong-ovate, about 2 mm long, nectar glands 4, lateral and median, ovary superior, bicarpellary, syncarps', linear, ovules 4–40, style distinct, stigma capitate or bilobed. Fruit siliqua, dehiscent, linear oblong, erect or slightly curved, compressed, valves papery, prominent midveined, about 2–5 cm long, torulose or smooth, glabrous or rarely pubescent, style short or obsolete. Seeds 4–20, uniseriate, not winged, light brown, globose-ovoid, about 1.5–1.8 mm across, minutely reticulate, mucilaginous when soaked, cotyledons conduplicate.

Brown mustard is widely cultivated for its edible seed which is a source of oil; is used to make the condiment 'brown mustard'; and is also sprouted as the mustard of mustard and cress [Flora Europea, Huxley, 1992][50]. It has only 70% of the pungency of black mustard (*Brassica nigra*) but can be harvested mechanically so is more viable commercially [Bown, 1995][15]. In addition to its edible uses, the plant also has a range of medicinal uses, is grown as a green manure and can be used to remove heavy metals from the soil.

It is mainly cultivated in Andhra Pradesh, Assam, Bihar, Delhi, Goa, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand, West Bengal.

Probably originating from the central Asian Himalayas to China, though it has been cultivated for so long that it is not known truly wild.

Known Hazards

An oil obtained from the seeds can have a high content of erucic acid. There have been some health concerns over the consumption of high levels of erucic acid in humans, though this is still controversial. Since 2012, several countries only allow cultivars with low erucic acid levels to be used for food.

Habitat

Cornfields in Britain [Clapham *et al.,* 1962][27]. Originating from the central Asian Himalayas to China, *Brassica juncea* has long been cultivated and many forms have been developed. Plants can be grown in the tropical lowlands as well as in much cooler conditions [Protabase, 2004][116]. The plant is reported to tolerate a temperature range of 6–37 °C and an annual precipitation of 500–4,000 mm [Protabase 2004][116].

Succeeds in full sun in most well-drained moisture-retentive fertile soils [Simons, 1977[134]; Huxley, 1992[75], Larkcom, 1980[88]]. Prefers a heavy soil and some shade [Simons, 1977][134]. Dislikes very hot weather [Organ, 1960][105]. Plants tolerate high rainfall and, although fairly deep rooted, are not very drought resistant [Larkcom, 1980[88]]. Tolerates a pH in the range 4.3 to 8.3.

The plant has escaped from cultivation in many areas and can become an invasive weed [Pacific Island Ecosystems at Risk http://www.hear.org/pier/scientificnames/index.html].

This species has also been cultivated in the Orient for many hundreds of years and a wide diversity of forms has been developed with edible leaves, stems, roots and seeds. These forms have been classified by the botanists as follows and separate entries have been made for each of them.

Brassica juncea integrifolia crispifolia. The curled or cut leaf mustards, this group has attractively curled edible leaves.

Brassica juncea integrifolia rugosa. Large some what cabbage-like edible leaves.

Brassica juncea integrifolia strumata. A form with large edible leaf stalks.

Brassica juncea integrifolia subintegrifolia. The leaf mustards have quite large smooth-edged edible leaves.

Brassica juncea japonica. Rather similar to Brassica junceacrispifolia and combined with that group by some botanists.

Brassica juncea napiformis. A form with a swollen edible root.

Brassica juncea tsatsaimulticeps. The multi-shoot mustard group.

Brassica juncea tsatsaitumida. A form with swollen edible stems.

Plants take from 2–5 months from sowing to maturity, depending on the season and the cultivar [Larkcom, 1991][91]. They prefer a fairly high stable temperature and are well adapted to short day length [Huxley, 1992][75]. Many are best grown in warmer climates than Britain but there are several cultivars that grow well in this country [Larkcom, 1980][90].

Plants have a rooting depth of between 90–120 cm [Duke, 1983][40].

A good bee plant [Komarov, 1968].[86]

Ethnobotanical Potential

Leaves consumed raw or cooked [Sholto-Douglas, Organ (1960)[133], Uphof (1959)[148], Larkcom, (1991)[89], Usher, (1959)[151]].

A peppery flavour that can range from mild to hot, this is one of the most highly prized cooked vegetables in the Orient [Larkcom, 1991].[89]

The leaves can also be eaten raw, when finely shredded they make a very acceptable addition to mixed salads [Larkcom, 1991].[89]

The protein extracted from the leaves mixes well with banana pulp and is well adapted as a pie filling [Facciola, 1990].[47]

Widely used as spice, leaves used as vegetable, seed oil used in pickles and cooking.

An edible semi-drying oil is obtained from the seed [Chittendon, (1951)[25]; Hedrick, (1972)[64]; Clapham *et al*., (1962)[27]; Schery and Facciola, (1990)[47]].

The seed contains 25–30% oil [Komarov, 1968].[86]

The seed is used as a mustard flavouring [Hill, 1952].[72]

It is the source of 'brown mustard' [Facciola, 1990][47], a prepared mustard that is milder than that produced from other species [Bown, 1995].[15]

Pungency of mustard develops when cold water is added to the ground-up seed-an enzyme (myrosin) acts on a glycoside (sinigrin) to produce a sulphur compound. The reaction takes 10–15 minutes. Mixing with hot water or vinegar, or adding salt, inhibits the enzyme and produces a mild bitter mustard [Bown, 1995].[15]

Black mustard comes from *B. nigra* and white mustard from *Sinapis alba*.

The seed is also used whole in curries and pickles [Bown, 1995].[15]

They are often heated in oil to destroy their pungency and give them a nutty flavour [Bown, 1995].[15]

The root of some forms of this species is edible [Faccicola, 1990].[47]

Sprouted seeds can be added to salads.

Flowers and young flowering stems-raw or cooked [Larkcom, 1980][88]. Sweet and succulent [Rice, 1987].[122]

Ethnomedicinal Potential

Although not usually used medicinally, the seed is a warming stimulant herb with antibiotic effects [Bown, 1995].[15]

Reported to be anodyne, aperitif, diuretic, emetic, rubefacient, and stimulant,

Brown Mustard is a folk remedy for arthritis, foot ache, lumbago, and rheumatism [Duke, 1983].[40]

The seed is used in the treatment of tumours in China [Duke, 1983].[40]

In Korea, the seeds are used in the treatment of abscesses, colds, lumbago, rheumatism, and stomach disorders [Duke, 1983].[40]

The root is used as a galactagogue in Africa [Duke, 1983].[40]

Ingestion may impart a body odour repellent to mosquitoes [Duke, 1983].[40]

Mustard oil is used in the treatment of skin eruptions and ulcers [Duke, 1983].[40] Believed to be aperient and tonic, the volatile oil is used as a counterirritant and stimulant [Duke, 1983].[40]

In Java the plant is used as an antisyphilitic emmenagogue [Duke, 1983].[40]

Leaves applied to the forehead are said to relieve headache [Duke, 1983].[40]

The Chinese eat the leaves in soups for bladder, inflammation or haemorrhage [Duke, 1983].[40]

The Bhotiya tribal communities of Niti Valley in Central Himalaya use *Brassica juncia* vegetable 1 bowl for a year or more to cure Anemia [Phondani *et al*., 2010].[112]

Agroforestry Uses

There is some evidence that if this plant is grown as a green manure it is effective in reducing soil-borne root rots in pea crops [Murray, 1991].

This is attributed to chemicals that are given off as the plants decay [Murray, 1991].

Brassica juncea has been found to have a high potential to remediate cadmium, lead and zinc from polluted environments. It is especially effective with lead, which it concentrates in the roots and greatly restricts its translocation to the shoots. This plant can therefore, be grown in environments that are contaminated with heavy metals, after which the plant biomass can be harvested and burned to ash to recover the metals or to be disposed of appropriately and safely [Anamica *et al*., 2009].[5]

The plant can be used as bioremediator to reduce boron and selenium levels in contaminated soils [Banuelos *et al*., 1992].[10]

An oil is obtained from the seed [Protabase, 2004].[116] It can be used as hair oil and as lubricant. The oil of cultivars bred for extra high erucic acid content is used for industrial purposes [Protabase, 2004].[116] A peculiar use of mustard oil is to retard the fermentation process when making cider from apples [Protabase, 2004].[116]

Propagation

Seed-sow in situ. Germination takes place within 5 days at 20–25 °C [Protabase, 2004].[116]

Brassica nigra (L.) W.D.J. Koch Black mustard, rajakshavak, Kali Mohari (*Brassica ceae*):

Common names in use

English: black mustard, brown mustard; German: schwarzer Senf, brauner Senf; Dutch: bruinemosterd; zwartemosterd (Belgium); Swedish: svartsenap, brunsenap; Danish: sort sennep, brunsennep; Norwegian: svartsennep; Icelandic: French: moutardebrune, moutarde noire; Italian: senapebruna, senape near; Spanish: mostazanegra; jenabe, jenape, ajenabe; Catalan: mostassanegra, mostallanegra; Portuguese: mostardanegra; Romanian: muştarnegru; Russian: belajagorčica, želtajagorčica, anglijskajagorčica; Polish: gorczycaczarna; Czech: hořčicečerná; Slovak: horčicačierná; Bulgarian: černagorčica, čerensinap; Croatian: slačicacrna, gorušicacrna; Greek: mavrosinapi; Turkish: karahardal; Hungarian: feketemustár, franciamustár; Finnish: mustasinappi; Estonian: Brassica sinapoides Roth (1830), SinapisincanaThuill.; Sinapisnigra L. (1753); Sisymbrium nigrum (L.) Prantl (1884) (Pl@nt Use).

Brassica nigra is a mustard whose exact native

range is uncertain but which is probably native to northern Africa, western and central Asia, and parts of Europe. It is widely cultivated, and has become naturalised in other parts of these continents as well as Australasia and the Americas. In California it is widespread and has invaded shrublands, grasslands, and riparian areas; it is listed as having a Moderate overall invasiveness score by the California Invasive Plant Council (Cal-IPC, 2004).[18] It is listed as a noxious weed in Michigan and as a noxious weed seed in several other US states (USDA-ARS, 2013).[149] It is listed as invasive in New Zealand, Hawaii and the off-shore islands of Chile (Encyclopedia of Life, 2013).[43]

A much-branched annual herb 0.5–1.5 m tall, with a firm taproot. Stem erect, terete, up to 1.5 cm in diameter, glabrous or bristly hairy, green or slightly glaucous. Leaves rather variable, petiolate, in a rosette and large in young plants, alternating and becoming gradually smaller further up the stem; lower leaves large, up to 16 cm x 5 cm, pinnatifid, usually with 2 lower lobes and a much larger terminal lobe, central leaves moderately lobed; lower and central leaves irregularly dentate and often partly bristly hairy; uppermost leaves narrow-lanceolate, small, entire, glabrous. Inflorescences axillary or terminal, bractless racemes, all together arranged paniculately; flowers bisexual, up to 8 mm long, 4-merous, bright yellow, on short pedicel; sepals 4, narrowly elliptical, 3–4 mm × 1.5 mm, spreading horizontally; petals 4, clawed-obovate, 6–8 mm × 2.5 mm; stamens 6, outer whorl of 2 shorter, inner whorl of 4 longer ones; pistil slightly shorter than longest stamens, with sessile, superior, elongated ovary and a style ending in a semi-globose stigma. Fruit a silique, 4-sided with rather flat sides, up to 2.5 cm long, with a short beak at apex, erect and closely appressed to the inflorescence axis, containing 4–10 seeds, dehiscing when ripe. Seed globose, about 1 mm in diameter, black to red-brown, minutely pitted. Seedling with epigeal germination.

Ethnobotanical Potential

More than 2,000 years ago, the plant was used as a condiment, it was mentioned by the Roman author Columella in the 1st century A.D.

The plant leaves were also pickled in vinegar.

The seedlings can also be used as a salading when about one week old, adding a hot pungency to a salad [Sturtevants, (1972); Vilmorin; Facciola, (1990)[47]; Ken Fern, (2014)[52]].

Immature flowering stems-cooked and eaten like broccoli [Facciola, 1990].[47]

In 13th century in France the seeds were ground and used. They were mixed with partially fermented grape juice to create "mout-ardent" (or burning must). This became later "moutarde", [Reader's Digest., 1981][120] now called mustard in English.

A spice is generally made from ground seeds of the plant, with the seed coats removed. The small (1 mm) seeds are hard and vary in colour from dark brown to black. They are flavourful, although they have almost no aroma. The seeds are commonly used in Indian cuisine, [The Guardian, 2014]. for example, in curry, where it is known as rai [food-india.com, 2017]. The seeds are usually thrown into hot oil or ghee, after which they pop, releasing a characteristic nutty flavour. The seeds have a significant amount of fatty oil, mainly oleic acid [Mejia-Garibay *et al*., 1015].[94] This oil is used often as cooking oil in India, it is called "sarson ka tel" [Borah, 2013].[13]

In Ethiopia, where it is cultivated as a vegetable in Gondar, Harar and Shewa, the shoots and leaves are consumed cooked and the seeds used as a spice. Its Amharic name is senafitch [Zemede, 1995].[159]

Black mustard is thought to be the seed mentioned by Jesus in Matthew 13:31–32 [Edward, 1900].[42]

Black mustard seeds are extremely versatile, and one of the few spices that are commonly used across all regions of India. They really are an unsung hero: widely used, but sadly not often understood. In a lot of Indian dishes, they are used as more of a seasoning than a base flavour–they really perk up a lentil or rice dish when fried in a little oil with curry leaves (a match made in heaven). For that reason, mustard seeds are great for healthy eating, when you want to add flavour without adding fat.

In the eastern regions of India, mustard seeds are often paired with fish, a classic combination in Bengali celebratory dishes; in the west of the country, they are used to perk up yoghurt and rice, as well as Gujarati coconut curries.

In Rajasthan they provide more of a base flavour for curries. Similarly, in Kashmir and Punjab, lamb is often cooked in mustard oil. Around Hyderabad, Chennai and Madras, they are key to rich, hot curries. As for the south – if there were 1,000 dosa, sambar or lentil recipes, I'd say that mustard seeds feature in 999 of them.

Try frying them in a little oil with a handful of curry leaves, then fold through yoghurt to serve with meats and curries, or stir through rice to add texture and flavour. You can also use them to

grow your own mustard cress–just soak them in water overnight, drain, then spread between damp kitchen cloths and leave in a warm place. The seeds will have sprouted within three days, and can be used in salads or as a garnish.

King prawns are baked with mustard and coconut.

The pungency of a yellow mustard sauce is elevated in flavour and texture by adding fried black mustard seeds.

Ethnomedicinal Potential

In the UK, the plant was used to make "hot mustard baths", which would aid people with colds [Reader's Digest, 1981].[120]

Ground seeds of the plant mixed with honey are widely used in eastern Europe as cough suppressant.

In Eastern Canada, the use of mouche de moutarde to treat respiratory infections was popular before the advent of modern medicine. It consisted in mixing ground mustard seeds with flour and water, and creating a cataplasm with the paste. This cataplasm was put on the chest or the back and left until the person felt a stinging sensation.

Mustard poultice could also be used to aid muscular pains. [Reader's Digest. 1981].[120]

Since the 1950s, black mustard has become less popular as compared to India mustard, because some cultivars of India mustard have seeds that can be mechanically harvested in a more efficient manner.

The seed of *B. nigra* has been used as a spice and medicine since ancient times in the Middle East, India and Greece. Finely ground seeds of black mustard provide mustard meal, a neutral odourless powder which stores well if kept dry. This meal, mixed with vinegar, is the pungent condiment or table mustard known as French and English mustard. Adding vinegar to a coarsely ground mixture of seeds of black mustard and of white mustard (Sinapis alba) produces the milder German or Dutch mustard. In Europe and North America, condiment mustard used to be prepared in the home by rolling a metal ball in a bowl of mustard seed and then mixing vinegar into the resulting crushed seed. Other herbs may be added according to taste and tradition and, for a milder taste, sugar, honey or starchy substances. There are numerous manufacturers' recipes. In cooking, mustard is mainly used to flavour meat dishes and sauces for meat, fish, salads, and snacks. In mayonnaise preparation it is also added as an emulsion stabilizer. The regulatory status of black mustard in the USA is 'generally recognized as safe'.

In traditional medicine, mustard meal mixed with water was used extensively as a plaster preparation and to prepare mustard baths to treat skin ailments, arthritis and rheumatism.

The seeds are used as a diaphoretic, diuretic, emetic, expectorant, irritant and stimulant.

Tea prepared from the seed is used to cure sore throat and to relieve bronchitis and rheumatism.

Hot water poured on crushed seed makes a household remedy for headaches and colds and a stimulating foot bath.

Mustard oil is said to stimulate hair growth.

Allyl isothiocyanate from *B. nigra* is used in cat and dog repellents.

B. nigra is a copious nectar producer and yields a mild-flavoured, light-coloured honey.

Naturalised or invasive *B. nigra* has no economic value.

Social Benefit

In California *B. nigra* is viewed by some as a beautiful wildflower which carpets the coastal landscape in yellow flowers in spring (Palenscar).

Environmental Services

B. nigra provides pollen to insects and bees.

It is unlikely that whole plant transportation would occur, but transport of *B. nigra* seed is likely, and it is seeds that would have to be detected. *B. nigra* seeds are dark brown to black with a pungent taste, spherical, and 1.2–1.5 mm wide (Palenscar).

In southern California it can be confused with shortpod mustard (Hirschfeldia incana), Sahara mustard (*B. tournefortii*) and field mustard (*B. rapa*) (Baldwin *et al*., 2012)[9]. *H. incana* is a biennial or short-lived perennial species. Siliques of both *B. nigra* and *H. incana* are short and appressed to the flowering stem. *B. nigra* generally has a single main stem that grows to over one metre tall, whereas *H. incana* generally has several stems that grow to one metre or less. Sahara mustard (*B. tournefortii*) has stiff hairy basal leaves and siliques that are spreading, not appressed. Field mustard (*B. rapa*) has cauline sessile leaves with no hairs.

Prevention

When *B. nigra* is grown as a crop, harvested plants

should preferably be bunched and put to dry on a floor. This ensures that most seeds will be collected and that there will be no large-scale seed losses in the field leading to subsequent massive growth of volunteer plants causing a weed problem.

Ecosystem Restoration

Active control of *B. nigra* is necessary to restore an ecosystem since the species alters soil chemistry, biota and ecology through allelopathy (Palenscar,).

A semi-drying oil is obtained from the seed, as well as being edible it is also used as a lubricant, illuminant and in making soap [Clapham, (1962)[27]; Lust, (1983)[91]; Uphof, (1959)[148]; Polunin, (1969)]

Mustard oil (allyl isothiocyanate) is used in commercial cat and dog repellent mixtures [Duke, 1983].[40]

Brassica rapa Linn. common mustard, wild mustard, wild turnip, forage turnip, wild rutabaga, birdsrape mustard, bird's rape, rape mustard; Horticultural cultivars: turnip, summer turnip, seventop turnip, rapini, broccoli raab, Italian kale; swede or white turnip (*Brassica ceae*):

Brassica rapa L. ssp. *rapa*, *Brassica rapa* L. var. *campestris* (L.) W.D.J. Koch, *Brassica campestris* L. ssp. *rapifera* (Metzger) Sinsk., *Brassica campestris* L. var. *rapa* (L.) Hartm., *Brassica napus* var. *quadrivalvis* (Hook. F. & Thomson) O.E. Schulz, *Brassica quadrivalvis* Hook. F. & Thomson, *Caulanthus sulfureus* Payson,

Synonyms

Brassica amplexicaulis Hochst. ex A. Rich; *Brassica antiquorum* H. Lév.; *Brassica asperifolia* Lam.; *Brassica asperifolia* var. *esculenta* Gren. & Godr.; *Brassica asperifolia* var. *oleifera* Godr.; *Brassica brassicata* A. Chev.; *Brassica briggsii* Varenne; *Brassica campestris* Linn.; *Brassica campestris* var. *afghanica* Sinskaya; *Brassica campestris* var. *agrestis*Prain; *Brassica campestris* var. *akana* Makino; *Brassica campestris* var. *amplexicaulis* Makino; *Brassica campestris* var. *annua* (Koch) Rchb.; *Brassica campestris* f. *auriculata* (DC.) O.E. Schulz; *Brassica campestris* var. *autumnalis* DC.; *Brassica campestris* var. *biennis* (Schübl. & G.Martens) Rchb.; *Brassica campestris* f. *briggsii* (Watson) O.E. Schulz; *Brassica campestris* var. *chinensis* (L.) N. Busch; *Brassica campestris* subsp. *chinensis*(L.) Makino; *Brassica campestris* subsp. *dichotoma* generic Olsson; *Brassica campestris* var. *dissecta* O.E. Schulz; *Brassica campestris* var. *glabra* Sinskaya; *Brassica campestris* var. *hiroshimana* Makino; *Brassica campestris* var. *mana* Makino; *Brassica campestris* var. *musifolia* Makino; *Brassica campestris* subsp. *narinosa* (L.H. Bailey) G. Olsson; *Brassica campestris* var. *narinosa* (L.H. Bailey) Kitam.; *Brassica campestris* f. *Oblonga* (Mill.) Prain; *Brassica campestris* var. *oleifera* DC.; *Brassica campestris* subsp. *oleifera* (DC.) Schübl. & Mart.; *Brassica campestris* var. *osakana* Makino; *Brassica campestris* var. *parachinensis* (L.H. Bailey) Makino; *Brassica campestris* subsp. *pekinensis* (Lour.) G. Olsson; *Brassica campestris* var. *pekinensis* (Lour.) Viehoever; *Brassica campestris* f. *praecox* DC.; *Brassica campestris* var. *purpuraria* L.H. Bailey; *Brassica campestris* var.*rapa* (L.) C. Hartm.; *Brassica campestris* subsp. *rapa* (L.) Hook. f.; *Brassica campestris* subsp. *rapifera* (Metzg.) Sinskaya; *Brassica campestris* var. *rubra* Sinskaya; *Brassica campestris* var. *sarson* Prain; *Brassica campestris* var. *setulosa* Caruel; *Brassica campestris* var. *sotetsuna* Makino; *Brassica campestris* f. *tenuis* O.E. Schulz; *Brassica campestris* subsp. *trilocularis* generic Olsson; *Brassica celerifolia* (Tsen & S.H. Lee) Y.Z. Lan & T.Y.Cheo; *Brassica chinensis* var. *angustifolia* V.G. Sun; *Brassica chinensis* var. *dentata* (Matsum. & Nakai) M. Hiroe; *Brassica chinensis* f. *hiroshimana* (Makino) M. Hiroe; *Brassica chinensis* f. *indivisa* (Makino) M. Hiroe; *Brassica chinensis* f. *japonica* (Siebold ex Miq.) M. Hiroe ; *Brassica chinensis* var. *komatsuna* Matsum. & Nakai; *Brassica chinensis* f. *komatsuna* (Matsum. & Nakai) M. Hiroe; *Brassica chinensis* f. *mana* (Makino) M. Hiroe; *Brassica chinensis* var. *musifolia* (Makino) M. Hiroe; *Brassica chinensis* var. *narinosa* (Bailey) M. Hiroe; *Brassica chinensis* var. *oleifera* Makino & Nemoto; *Brassica chinensis* f. *osakana* (Makino) M.Hiroe; *Brassica chinensis* var. *pandurata* V.G. Sun; *Brassica chinensis* var. *parachinensis* (L.H. Bailey) Sinskaya; *Brassica chinensis* var. *pekinensis* (Lour.) V.G. Sun; *Brassica chinensis* var.*petsai* (L.H. Bailey) Maire & Weiller; *Brassica chinensis* f. *piaoh-tsai* (Kitam.) M. Hiroe; *Brassica chinensis* var. *rosularis* Tsen & S.H. Lee; *Brassica chinensis* f. *youngtungtsai* (Kitam.) M. Hiroe; *Brassica cibaria* Dierb.; *Brassica colza* H. Lév.; *Brassica cyrenaica* Spreng.; *Brassica dubiosa* L.H. Bailey; *Brassica japonica* Makino [Illegitimate]; *Brassica japonica* var. *indivisa* Makino; *Brassica japonica* var. *isena* Makino; *Brassica japonica* var. *suigikuna* Makino; *Brassica juncea* var.*celerifolia* Tsen & S.H. Lee; *Brassicalutea* Gilib. [Invalid]; *Brassica macrorhiza* Gray; *Brassica musifolia* (Makino) Makino [Invalid]; *Brassica napella* Chaix; *Brassica napus* var. *chinensis* (L.) O.E. Schulz; *Brassica napus* var. *longirostris* Borbás; *Brassica narinosa* L.H. Bailey; *Brassica nipposinica* L.H. Bailey; *Brassica oleracea* var. *chinensis* (L.) Prain; *Brassica oleracea* var. *taquetii* H. Lév. & Vaniot; *Brassica oleronensis* A.

Sav. ex Foucaud; *Brassica parachinensis* L.H. Bailey; *Brassica pe-tsai* var. *dentata* Matsum. & Nakai; *Brassica pekinensis* Skeels; *Brassica pekinensis* (Lour.) Rupr.; *Brassica pekinensis* var. *cephalata* Tsen & S.H. Lee; *Brassica pekinensis*var. *cylindrica* Tsen & S.H. Lee; *Brassica pekinensis* var. *hiroshimana* Makino; *Brassica pekinensis* var. *laxa*Tsen & S.H. Lee; *Brassica pekinensis* var. petsai Lour.; *Brassica perfoliata* Crantz; *Brassica perviridis* (L.H. Bailey) L.H. Bailey; *Brassica petsai* (Lour.) L.H. Bailey; *Brassica polymorpha* Syme [Illegitimate]; *Brassica pseudocolza* H. Lév.; *Brassica purpuraria* (L.H. Bailey) L.H. Bailey; *Brassica quadrivalvis* Hook.f. & Thomson; *Brassica rapa* subsp. *afghanica* (Sinskaya) Shebalina; *Brassica rapa* f. *alba* DC.; *Brassica rapa* var. *alborosea* Shebalina; *Brassica rapa* var. *amplexicaulis* Yo. Tanaka & Ono; *Brassica rapa* var. *annua* W.D.J. Koch; *Brassica rapa* f. *arenaria* Alef.; *Brassica rapa* var. *briggsii* Briggs; *Brassica rapa* var. *campestris* (L.) Peterm.; *Brassica rapa* subsp. *campestris* (L.) A.R. Clapham; *Brassica rapa* var. *cephalata* (Tsen & S.H. Lee) Hanelt; *Brassica rapa* var. *chinensis* (L.) Kitam.; *Brassica rapa* subsp. *chinensis* (L.) Hanelt; *Brassica rapa* f. *chloroplax* Alef.; *Brassica rapa* f. *cinerascens* Alef.; *Brassica rapa* var. *communis* (Tsen & S.H. Lee) Hanelt; *Brassica rapa* var. *cylindrica* (Tsen & S.H. Lee) Hanelt; *Brassica rapa* var. *depressa* DC.; *Brassica rapa* f. *depressa* (DC.) Prain; *Brassica rapa* subsp. *dichotoma* (Roxb. ex Fleming) Hanelt; *Brassica rapa* var. *dichotoma* (Roxb. ex Fleming) Kitam.; *Brassica rapa* var. *dissecta* (O.E. Schulz) Gladis; *Brassica rapa* f. *erythroplax* Alef.; *Brassica rapa* f. *flavescens* DC.; *Brassica rapa* var. *glabra* Regel; *Brassica rapa* var. *globosa* Peterm.; *Brassica rapa* var. *hybrida* Shebalina; *Brassica rapa* var. *intermedia* Shebalina; *Brassica rapa* subsp. *japonica* Shebalina; Brassica rapa f. jodopyrga Alef.; Brassica rapa var. laxa (Tsen & S.H. Lee) Hanel *Brassica rapa* var. *leptorhiza* Spach; *Brassica rapa* f. leucoplax Alef.; *Brassica rapa* f. *leucopyrga* Alef.; *Brassica rapa* f. *lugdunensis* Alef.; *Brassica rapa* f. *media* Alef.; *Brassicarapa*f. *melaina* Alef.; *Brassica rapa* f. *morignyana* Alef.; *Brassica rapa* f. *nagakabu* Kitam.; *Brassica rapa* subsp. *narinosa* (L.H. Bailey) Hanelt ; *Brassica rapa* var.*narinosa* (L.H. Bailey) Kitam.; *Brassica rapa* f. *nigricans* DC.; *Brassica rapa* subsp. *nipposinica* (Bailey) Kitam.; *Brassica rapa* var. *nipposinica* (Bailey) Hanelt; *Brassica rapa* subsp. *nipposinica* (L.H. Bailey) Hanelt; *Brassica rapa* var. *oblonga* (Mill.) DC.; *Brassica rapa* var. *oleifera* DC.; *Brassica rapa* subsp. *oleifera* (DC.) Metzg.; *Brassica rapa* var. *oleronensis* (A.Sav. ex Foucaud) Sav.; *Brassica rapa* var. *pandurata* (V.G. Sun) Gladis; *Brassica rapa* var. *parachinensis* (Bailey) Hanelt; *Brassica rapa* subsp. *pekinensis* (Lour.) Kitam.; *Brassica rapa* var. *pekinensis* (Lour.) Hanelt; *Brassica rapa* subsp. *pekinensis* (Lour.) Hanelt; *Brassica rapa* var.*perviridis* L.H. Bailey; *Brassica rapa* f. *punicea* DC.; *Brassica rapa* var. *purpuraria* (L.H. Bailey) Kitam.; *Brassica rapa* var. *quadrivalvis* (Hook. f. & Thomson) Kitam.; *Brassica rapa* subsp. *rapa; Brassica rapa* var. *rapa*; *Brassica rapa* subsp. *rapifera* Metzg.; *Brassica rapa* var. *rosularis* (Tsen & S.H. Lee) Hanelt; *Brassica rapa* var. *rubra* (Sinskaya) Shebalina; *Brassica rapa* var. *sarcorhiza* Spach; *Brassica rapa* subsp. *sarson* (Prain) Denford; *Brassica rapa* var. *sativa*Mérat; *Brassica rapa* var. *septiceps* L.H. Bailey; *Brassica rapa* var. *trilocularis* Kitam.; *Brassica rapa* f. *variegata* Alef.; *Brassica rapa* var. *violascens* Shebalina; *Brassica rapa* f. *viridis* DC.; *Brassica rapa* f. *xanthocona* Alef.; *Brassica rapa* f. *xanthoplax* Alef.; *Brassica* rapifera (Metzg.) Dalla Torre & Sarnth.; *Brassica rapoasiatica* Sinskaya; *Brassica rapoeuropea* Sinskaya; *Brassica saruna* Siebold; *Brassica sativa* var. *campestris* (L.) Clavaud; *Brassica sativa* var. *rapa* (L.) Clavaud; *Brassica septiceps* (L.H. Bailey) L.H. Bailey; *Brassica sphaerorrhiza*Gray; *Brassica trilocularis* Hook. f. & Thomson; *Brassica trimestris* Boenn.; *Brassica tuberosa* Salisb.; *Caulanthus sulfureus* Payson; *Cruciferarapa* E.H.L. Krause; *Napus campestris* (L.) Schimp. & Spenn.; *Napusrapa* (L.) Schimp. & Spenn.; *Raphanus campestris* (L.) Crantz; *Raphanus chinensis* (L.) Crantz; *Raphanusrapa* (L.) Crantz; *Sinapiscommunis* Noronha; *Sinapis dichotoma* Roxb.; *Sinapis glauca* Roxb.; *Sinapis pekinensis* Lour.;*Sinapisrapa* (L.) Brot.; *Sinapis tuberosa*Poir..

Brassica rapa is a plant consisting of various widely cultivated subspecies including the turnip (a root vegetable); napa cabbage, bomdong, bok choy, and cime di rapa (leaf vegetables); and Brassica rapa subsp. oleifera, an oilseed which has many common names, including turnip rape, field mustard, bird rape, and keblock [GRIN, (2013); EOL, (2013); Clive Stace, (1997)[29]; Baileys Dictionary, (1731)[8]; Hurst, (1889); Bio image. Cas. Vanderbilt Edu. (2011)].

The oil made from the seed is sometimes also called canola or colza [GRIN, 2013], which is one reason why it is sometimes confused with rapeseed oil, but this comes from a different Brassica species (Brassica napus). The oilseeds known as canola are sometimes particular varieties of Brassica rapa (termed Polish Canola) but usually the related species Brassica napus (rapeseed) and Brassica juncea (mustard greens and mizuna) [Chapter-2-Canola Varieties, 2014].

Researchers at the University of Wisconsin–Madison have selectively bred one subspecies of *B. rapa* to have an extremely short life cycle for use as a model organism in education and experiment.

This variety is known by the trademarked name "Wisconsin Fast Plants." [Wisconsin Fast Plants, 2017].[155]

In the 18th century the turnip and the oilseed-producing variants were seen as being different species by Carl Linnaeus who named them *B. rapa* and *B. campestris*. 20th-century taxonomists found that the plants were cross fertile and thus belonged to the same species. Since the turnip had been named first by Linnaeus, the name *Brassica rapa* was adopted [Thomet, 2003].[141]

Many butterflies, including the small white, pollinate the *B. rapa* flowers.

Field mustard is an upright winter annual or biennial that is a member of the mustard family (Brassicaceae). Plants exist as basal rosettes until flowering stems develop at maturity, usually in the second year. Plants grow 1 to 3 (or 4) ft tall from a sometimes fleshy, enlarged taproot, with a many-branched stem. The foliage is generally hairless and sometimes covered with a whitish film. Lower leaves can reach 12 inches long, have a large central lobe, and usually one to four pairs of smaller side lobes. Upper leaves are smaller, non-lobed, and have a pointed tip and widened, clasping base. The bright yellow flowers are clustered at stem tops and have four petals that are ¼ to ½ inch long. Plants flower from January to September, depending on climate and latitude, and are insect pollinated and self-incompatible. The fruit is an elongated, two-parted capsule that splits open at the base to release the seeds at maturity. Each half of the pod has a single prominent lengthwise vein that distinguishes it from those of other Brassica species that have 3 to 7 veins. The hairless seed pods are ¾ to 4 inches long, with a narrow beak at the tip, and are born on long, ½– to 1-inch stems that point outward or upward. Seeds are about 1/16-inch-wide, nearly round, and reddish-gray to black [DiTomaso and Healy, (2007)[36]; Jepson Flora Project, (2012)[80]; Pojar and MacKinnon, (1994)[115]; Taylor, (1990)[140]; Turner and Gustafson, (2006); Warwick, (2010)[153]; Whitson *et al*., (2006)].

Field mustard grows in disturbed areas including roadsides, ditches, cultivated fields, orchards, and gardens.

Adaptation

Field mustard is an extremely adaptable plant that grows in sandy to heavy clay soils and tolerates a pH range from 4.8 to 8.5 (Hannaway and Larson, 2004). It grows best in well-drained, moist soil, but may also grow in droughty conditions, moderate heat, and soils with low fertility (Clark, 2007).[28] Although it grows best in full sun, it will grow in moderate shade. Field mustard is hardy through USDA plant hardiness zone 7.

Ethnobotanical Potential

Cover crop

Field mustard is used as a winter annual or rotational cover crop in vegetable and specialty crops as well as row crop production. It has the potential to prevent erosion, suppress weeds and soil-borne pests, alleviate soil compaction, and scavenge nutrients (Clark, 2007).[28] It has rapid fall growth, high biomass production, and nutrient scavenging ability following high input cash crops. Field mustard can be grown as a cover crop alone or in a mix with other brassicas, small grains, or legumes. In the Northeast, Mid-Atlantic, and Great Lakes bioregions, it appears to be a good tool as a biofumigant cover crop for control of nematodes, soil-borne diseases including the fungal pathogen (*Rhizoctonia)* responsible for damping-off, weeds, and other pests. When biomass is incorporated into the soil, soil microbes break down sulfur compounds in the plant into isothiocyanide, which can act as a fumigant and weed suppressant (Olmstead, 2006).[104] Field mustard produces 2,000 to 5,000 pounds of dry matter per acre per year and biomass contains 40 to 160 lb/acre total N (Clark, 2007).[28]

Intercropping

Intercropping can increase cropping system diversity and profitability by producing two simultaneous crops on the same land. In New Mexico, forage turnip was interseeded between rows of chili peppers and sweet corn without affecting yields of the cash crop when the turnip seeding was timed correctly (Gulden *et al*., 1997a, 1997b).[60]

Forage

Cultivars with larger roots, commonly called forage turnip, have been a popular forage crop for livestock in Europe and Asia for at least 600 years (Undersander *et al.,* 1991).[147] Forage turnip is a useful crop for extending the fall grazing season for dairy cows and other livestock [Thomet and Kohler, (2003)[141]; UMass Extension, (2012)[146]]. Forage turnip was largely replaced with corn silage in the early 1900s because it required less labor. The use of

forage turnip increased again in the 1970s with the development of new cultivars that could be seeded directly into pastures. Aboveground vegetation contains 20 to 25% crude protein, 65 to 80% in vitro digestible dry matter (IVDDM), about 20% neutral detergent fiber (NDF), and about 23% acid detergent fiber (ADF). The roots contain 10 to 14% crude protein, and 80 to 85% IVDDM (Undersander *et al*., 1991).[147]

Field mustard roots and leaves were used as food by many Native American tribes following introduction of the plant by white settlers (Moerman, 2012).[95]

Ethnomedicinal Potential

Various parts of the plant have been used as a folk remedy for different types of cancer, either by boiling the mashed stems and leaves, powdering the seeds, or making a salve from the flowers [Duke, (1983)[40]; Plants for a Future, (2012)[114]].

Brassica schimperi Boiss. 1842 Eithiopian kale (*Brassica ceae*):

Synonyms

Brassica arabica (Fisch. & C.A. Mey.) Fiori; *Diplotaxis inopinata* Sprague; *Sisymbrium abyssinicum* E. Fourn.; Sisymbrium hararense Engl.

Erucastrumar abicum is an annual plant growing up to 1 metre tall. It can be branched or unbranched [Protabase, 2004].[116]

It is commonly grown in Africa-Sudan, Eritrea, Djibouti, Ethiopia, Somalia, eastern DR Congo, Uganda, Kenya, Rwanda, Burundi, Tanzania, Namibia, Botswana, Zimbabwe, S. Africa.

It is an introduced weed in cultivated land in many parts of the world [Protabase, 2004].[116]

The habitat of the plant is disturbed places in upland forest, a weed in cultivated land; at elevations from sea level to 3,170 metres, though mainly at 1,500–2,000 metres [Protabase, (2004)[116]; African Flowering Plants Database[2]].

Known Hazards

In Ethiopia it is believed by some that eating this plant can have side effects such as drowsiness and drying of the skin [Protabase, 2004].[116]

Ethnobotanical Potential

The plant is harvested from the wild for local use as a food, and possibly also as a source of oil.

It is also grazed by domestic stock [Ptotabase, 2004].[116]

Leaves are consumed fresh raw or cooked [Protabase, 2004].[116]

The above-ground parts are chopped and boiled in salty water for about one hour, and eaten as a vegetable in sauces or soups [Protabase, 2004].[116]

The young leaves are also be eaten raw as a salad [Protabase, 2004].[116]

In some areas the plant is considered a typical famine food, though in other areas it is seen as a normal wild vegetable [Protabase, 2004].[116]

The oil from the seed is possibly used as food after refining [Protabase, 2004].[116]

The seed contains about 35% oil [Protabase, 2004]. It is possibly used for lighting purposes [Protabase, 2004][116] [Ken Fern, 2014].[52]

In Ethiopia seeds are occasionally sold in local market with the same vernacular name as Brassica carinata A. Br. (meshisha) which is highly appreciated vegetable and which has a useful seed oil for burning, cooking after refining and traditional medicine [Prota, 2004].

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Food Allergy and Risk Management

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Abstract

Food allergy is an adverse immune response to a normally tolerated food protein.[44] Generally, food allergic reactions are mediated by immunoglobulin E (IgE) and occur in individuals who are genetically predisposed to the allergy and who have been previously exposed to the allergen. Food allergies have become an important health concern worldwide. The symptoms of food allergy include respiratory, gastrointestinal and cardiovascular symptoms and a rare life threatening symptom includes anaphylactic shock. The substance that causes an allergic reaction is called an allergen. More than 160 foods are identified as allergenic. Approximately 90 percent of all the allergenic reactions to food are caused by eight major foods namely milk, eggs, fish, crustacean, shellfish, tree nuts, peanuts, wheat, and soybeans.[10] Currently there is no cure for food allergy. Therefore, proper management is very much important to reduce the risk of food allergy. Several research efforts are ongoing to develop anti-allergenic as well as hypoallergenic foods by using various processing technologies to eliminate the causative factor. Hence, understanding the recent status of food allergy and advanced processing technologies are required for reducing allergenicity of foods.

Keywords: Food allergy; Allergen; Anaphylactic shock; Anti allergenic food; Hypoallergenic food.

Introduction

Food is necessary for survival, but sometimes a morsel can kill. Food allergies have become a burning health concern worldwide. It is an adverse reaction to specific food by the immune system. Food allergy is a major health problem affecting up to 5% of adults and 8% of children worldwide.[19] It has been defined as an IgE-mediated abnormal response to very low quantities of certain food proteins.[38] Symptoms are diverse ranging from relatively mild to severe or sometimes even fatal consequences.[43] Clinical manifestations of food allergies in sensitized individuals can range from minor digestive disorders and skin irritations to more severe symptoms that can even lead to life threatening situations. To provide all consumers with better information and to protect the health of certain consumers, several countries have introduced into their legislation the obligation to indicate the presence of certain allergenic ingredients on food labels.

Food allergies are an abnormal response of the body to otherwise harmless foods involving the immune system. Normally, our immune system defends against possibly harmful substances, such as bacteria, viruses, and toxins. However, the immune system of allergic individuals incorrectly identifies certain food constituents as harmful. The severity of an allergic reaction may vary between individuals. While one person may have to rush

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to the nearest emergency room within minutes of eating a food allergen because of life-threatening symptoms, another person may only develop itching in the mouth. The reaction may develop within a few minutes or a few hours.

Currently there is no cure for food allergy and food allergic individuals must completely avoid the sensitive foods.[36] Absolute avoidance of the foods is difficult in the modern days because of the use of major allergens as ingredients in other food products and contamination caused by processing in same facility that handles allergenic foods.[49] Risk assessment and management of food allergy is very difficult because of several reasons: (1) Non-allergic people can consume different food allergens without any risk unlike other chemical and microbiological hazards like toxins and harmful bacteria. (2) Almost all of the major allergenic foods provide nutrition and are part of daily food consumption for survival. (3) The sensitivity to food allergens varies vastly from one patient to other who is allergic to the same food. Hence no two allergenic foods can have similar risk management strategies.[7]

Prevalence of food allergy

Food allergies are an important health issue that are considered by the World Health Organization among the five most important public health concerns,[24,16] particularly in industrialized countries, where the affected population represents approximately 2% of adults and up to 4–8% of young children.[20,12] Globally 200–500 million people suffer from food allergy and it affects the quality of life mainly children (5–8%). In adults, the prevalence is considerably low (1–2%) and no country has reported decline in food allergy in the last decade.[39] India reflects 1–2% prevalence of food allergy which is found more among children when to compared to adults.[30]

Allergens

A substance that causes an allergic reaction is called an allergen. Food allergens are the components of food that can cause adverse immunological reactions when consumed**.** More than 160 foods are identified as allergenic. Approximately 90 percent of all the allergenic reactions to food are caused by eight major foods namely milk, eggs, fish, crustacean, shellfish, tree nuts, peanuts, wheat, and soybeans. The other 10 percent of the allergenic food reactions are caused by remaining foods that are identified as allergens and are less prominent.[40]

Table 1: Food allergens from animal sources

Food	Major allergenic proteins	References
Cow's Milk	b-lactoglobulin	[34]
	Casein	[52]
	a-lactalbumin	
Egg	**Hen's Egg White**	[5]
	Ovomucoid	[21]
	Ovalbumin	[50]
	Ovotransferrin	[41]
	Lysozyme	
	Egg yolk	
	a-livetin	
Fish	Parvalbumin	[41]
Shrimp	Pen a 1 (Tropomyosin)	[3]

Table 2: Food allergens from plant sources

Food	Major allergenic proteins	References
Tree nuts	Pru du 6 from almond	[14]
	Ber e 1 from Brazil nut	[42]
	Ana o 1 and Ana o 2 from cashew	
	Cor a 1 from hazelnut	
Peanut	Ara h 1	[31]
	Ara h 2	[32]
	Ara h 3	[25]
Soybean	Gly m Bd 30 K	[37]
	Gly m Bd 60 K	[54]
	Gly m Bd 28 K	

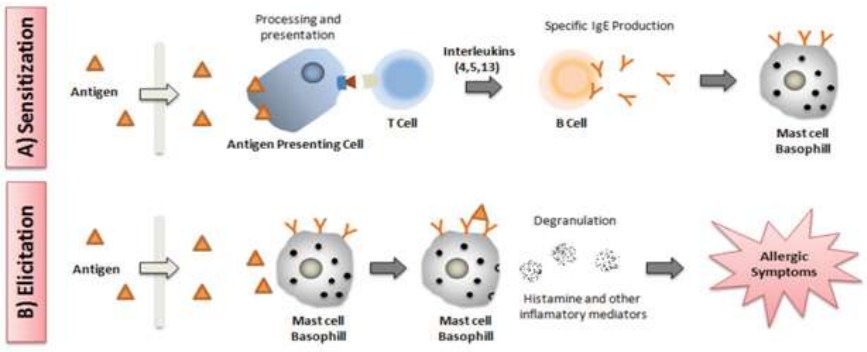

Fig. 1:

Mechanism of food allergy

The development of an allergy occurs in two stages (Figure 1):

Sensitisation: When a person is first exposed to a food (may be before birth), the food may trigger immune system cells to produce large amounts of IgE that specifically recognizes that food.

Reaction: Once sensitised, even a tiny quantity of that allergen can lead to an allergic reaction. When the person eats the same food again, the allergen triggers the newly armed immune system, which leads to allergy symptoms.

Signs and symptoms: Clinical symptoms that are associated with the ingestion of foods by sensitive persons include urticaria, itching, edema, bronchoconstriction, rhinitis, vomiting, diarrhea, cramps, and, in severe cases, cardiovascular symptoms that may lead to anaphylactic shock, which may have fatal consequences.[5]

Risk management of food allergy

Currently there is no cure for food allergy and food allergic individuals must completely avoid the sensitive foods.[47] Absolute avoidance of the foods is difficult in the modern days because of the use of major allergens as ingredients in other food products and contamination caused by processing in same facility that handles allergenic foods.[49] Therefore, a proper risk management strategy is very much essential to eliminate the seriousness of food allergy. The development of food allergy could be prevented by blocking any steps in the allergic reaction sequence, from allergen absorption to inflammatory reaction. Food allergy can be prevented by

(i) Blocking allergen invasion/recognition

(ii) Blocking T-cell activation

(iii) Blocking the binding of allergens with IgE antibodies

(iv) Blocking the release of chemotransmitters.

Risk management of allergenicity by food-oriented approach

1. *Exclusive breastfeeding:* Breast milk contains a host of immunologically active compounds, such as transforming growth factor – beta, lactoferrin, lysozymes, long-chain fatty acids, antioxidants and secretory IgA (sIgA), all of which have an effect on immune development, including oral tolerance and help to reinforce the gut-epithelial barrier.[8,22] There is evidence that exclusive breastfeeding for the first 6 months from birth protects against wheezing in early life.[18] On the other hand infant formulas should be given in the first 4 to 6 months only if exclusive breastfeeding is not possible for some reason.
2. *Avoid the allergenic food:* The elimination of the allergenic food from the diet of an individual with allergy is the simplest way to reduce allergy. But food avoidance should always be parallel with inclusion of food substitutes to balance the nutritional intake. On the other hand, eating meals away from home can be risky for individuals with food allergies. Whether at a fancy restaurant or a fast-food establishment, inadvertent exposure to an allergen can occur, even among the most knowledgeable individuals.
3. *Label reading:* Labeling is an important part of a food package and it helps the consumers to identify the potential allergen present in it. Since January 1, 2006, the Food Allergen Labeling and Consumer Protection Act (FALCPA) requires the top 8 allergens to be listed clearly on the food labels. This includes ingredients in any amount and also mandates specific ingredients to be listed such as the type of nut or seafood.

Risk management of allergenicity by food processing

Food Processing may alter the structures and availability of epitopes for binding to IgE. Processing may be thermal or non-thermal.

Thermal Processing

The effect of thermal treatment on food allergens has been widely researched due to its wide application in food processing.[44] Heat treatment can denature some proteins and thus change the native structure. The conformational epitopes are altered during denaturation due to the modification of secondary and tertiary structure which may reduce the IgE binding. Depending on the type of protein, temperature and extent of heating, heat treatment may induce unfolding which can be reversible or irreversible.[33] Each protein exhibits different resistance to heat treatment. Moreover the response

of a food allergen to heat depends on whether the heat is dry or moist.[6] Fruit allergens such as Mal d 1 and Pru av 1 are more heat labile, whereas Gly m 4 of soy are more heat stable.[44] Examples of food allergens that are highly resistant to heat treatment include casein,[1] tropmyosin[45] and ovomucoid.[4]

Thermal treatment may also lead to formation of neoantigens that are not present originally. The generation of neoantigens may enhance the allergenic problem in sensitized patients. One of the factors responsible for the formation of neoantigens maybe maillard reaction, e.g., the interaction of the protein component with sugar residues upon heating, generating sugar conjugated protein derivatives, that in turn increases the allergenicity of protein.[51]

The effect of heating on allergenicity of different foods-

1. *Legumes:* Boiled lentils extract keeps its allergenicity. Soybean allergen globulin, when heated, lost partly its allergenicity. Decrease allergenicity of chickpea on boiling, but may have no change on antigenic behaviour as in the case of boiling pea allergens.
2. *Fish and seafood:* Cooking of fish caused denaturation and coagulation of proteins but some bands presented IgE binding. Canning of fish caused the reduction in IgE binding.
3. *Meat and meat products:* Allergenicity of pork sausages decreases after autoclave treatment.
4. *Peanuts and other nuts:* Roasting, autoclaving, blanching, microwave heating of almonds indicated antigenic stability of almond proteins when compared with that of the unprocessed nuts. Hazelnut protein presented high heat stability and can be detected even after treatment at 185 °C. Peanut roasting, increases the allergenicity of the final product.
5. *Fruits and vegetables:* In case of peach, sterilization is not able to decrease the allergenicity of the Pru p 1 protein.
6. *Milk and milk products:* In cow milk, *α-casein* is the most stable, bovine serum albumin is the most heat labile and *β*-lactoglobulin is relatively heat stable. Bu *et al*. (2013) studied the effect of thermal processing on milk proteins and reported that α-latalbumin and β-lactoglobulin had increased allergenicity from 50 to 90 °C whereas the allergenicity decreased when heated above 90 °C.[9]

Non – thermal Processing

Although thermal treatment may reduce allergic reactions of some thermal labile proteins, non-thermal processing offers several advantages over non-thermal processing because of retention of nutrition and natural attributes such as aroma, color, and flavor. Nonthermal treatments are proved to be effective in killing harmful bacteria in different food products with minimum effect on the quality.[4]

Recent research on the effect of nonthermal treatments in altering allergenicity of food proteins showed that these treatments can reduce the allergencity of different food allergens.[35] Pulse ultraviolet light, high intensity ultrasound, nonthermal atmospheric plasma, gamma irradiation, genetic modification, physical, chemical and enzymatic processing are some of the nonthermal treatments shown to have the ability to alter the allergenicity of different food allergens.[35] Some of these processes have been described below:

a. *Enzyme Treatment:* Enzymatic treatment hydrolyzes the protein with enzymes and reduces the allergenicity. This treatment destroys the structure of proteins and alters its properties. Development of off flavor and bitterness due to the release of peptides and amino acids makes the enzymatic hydrolyzed product often unacceptable for consumption.[15] Expensive equipment and ingredients were the major disadvantages of this treatment.
b. *Bacterial Culture:* Mesophillic and thermophillic strains of bacterial cultures were shown to have reduced the allergenicity of cow milk proteins when tested with in vitro system. Lactic acid bacteria fermentation can reduce the immunoreactivity of sterilized cow milk by 90% while preserving the organoleptic properties of the product.[23]
c. *Genetic Modification:* Genetic modification process can be applied to prevent translation of selected allergens using post-transcriptional gene silencing or co-suppresion. Stability of these foods has not been determined and this process might lead to the change in functional and physical properties of foods.[46]
d. *Gamma Irradiation:* Gamma irradiation was regarded as an effective method to reduce the allergenicity of shrimp and milk allergens.[28] However consumer resistance and need for large investments makes it difficult for application in food industry.[29]

e. *Ultraviolet Light:* Researchers used ultraviolet (UV) light as a bactericidal agent since the year 1928.[52] The effect of UV radiation on food allergenicity varies depending on the amino acid composition and molecular structure of the protein.[17] A 7 fold reduction in IgE binding of peanut allergens in Ci-ELISA analysis was obtained by treating peanut extract and liquid peanut butter with pulsed UV light treatment.[11]

Development of product based on proceesing techniques

Development of hypoallergenic food

Currently, food allergy is mainly treated symptomatically through medication and removal of the causal food. However, the elimination of allergen-containing food from the diet of growing infants is undesirable, as it may lead to nutritional deficiency or developmental disturbance. The development of hypoallergenic food through the degradation or denaturation of allergens is essential to prevent nutritional disorders or growth disturbance and to maintain a rich and varied diet. Therefore, it is required that hypoallergenic food is nutritionally identical to normal food and shows minimum allergenic activity.

To date, several methods for reducing allergens in crops or food products have been developed and applied to commercial products. One such example is "Fine Rice," which has been developed through joint research between Shiseido, the Faculty of Agriculture of The University of Tokyo and the School of Medicine of Yokohama City University, and was commercialized in 1991. Fine Rice has been produced through the protease treatment of rice, which has led to the decomposition of globulin, an allergenic protein. The product was approved by the Ministry of Health and Welfare as the first "food for specified health uses" in June 1993 and as "food for medical purpose" in June 1997. Another example of hypoallergenic rice is that developed by Mitsui Toatsu Chemicals, Inc. (currently Mitsui Chemicals, Inc.) and the National Institute for Agro – Environmental Sciences, in which the expression of allergenic proteins has been suppressed by genetic engineering. The National Agricultural Research Center for Tohoku Region has developed a hypoallergenic soybean variety named "Yumeminori" lacking two of the three major allergens found in soybeans.

Development of anti-allergic food

Anti-allergic food prevents or controls food allergy by inducing oral tolerance or utilizing gut immunity and anti-allergic food components.

(1) *Anti-allergic food based on oral tolerance induction:* Oral tolerance is a phenomenon in which proteins in orally ingested food do not induce excessive immune responses, despite the fact that food has a vast amount of antigenic substances containing foreign proteins. Food allergy is induced when a specific allergen is orally ingested and absorbed by the body via the digestive tract. It has been reported that oral tolerance to acertain antigen is induced by the protein itself or by a peptide of the protein. In other words, it may be possible to suppress an allergic reaction by inducing oral tolerance using a peptide that reacts with the T-cell but does not bind to the IgE antibody involved in the allergic reaction.

(2) *Anti-allergic food based on mucosal immunity in the gut:* Microbes such as lactic bacteria in cheese, yogurt and other fermented dairy products improve the storage quality and taste of milk and its nutritional value through proteolysis, lactose degradation and vitamin synthesis. They also improve the gut microflora and have other health effects such as intestinal regulation, normotension and immune stimulation. Recently, probiotics have attracted attention for their effect of enhancing the immune regulatory function of the digestive tract and suppressing or ameliorating allergic symptoms. There is a difference in gut microflora between people with and without allergy, and smaller numbers of lactobacillus, a kind of lactic bacteria, have been found in the former compared to the latter group. This report has triggered a series of research projects on probiotics including lactic bacteria and the development of probiotic-based products with anti-allergic effects.

(3) *Use of anti-allergic components:* One way to prevent the development of food allergy is to suppress the production or action of chemotransmitters such as histamine and leukotriene that trigger the inflammatory response in the allergic reaction sequence. The production or action of chemotransmitters is called anti-allergic action. While hypoallergenic food involves antigen-specific suppression, anti-allergic action works in a non-specific manner, suppressing allergic reactions independent of the allergen type. Many food components are known to have anti-allergic

actions. For example, highly unsaturated fatty acids such as eicosa pentaenoic acid and docosa hexaenoic acid, which are abundant in fish, suppress leukotriene production, and tea polyphenol suppresses histamine and leukotriene release. Anti-allergic actions have also been reported in tea catechin and caffeine. Additional anti-allergic components have been identified in various foods, including flavonoids, sesamin and perilla leaf extract, development of probiotic-based products with anti-allergic effects.

Conclusion

Lucretius of Greece once said, "One man's food might be another man's poison." Food allergy is a significant health problem, with increasing prevalence and potentially life-threatening sequelae. Over-diagnosis of food allergy may also lead to unnecessary avoidance of food, resulting in an impaired quality of life. Recent advances in various processing techniques offer great promise to the food processors to develop hypoallergenic foods and to ensure delivery of safe food to consumers. Future progress in research and development requires not only setting individual research tasks but also discussing the evaluation of the efficacy and safety of anti-allergic foods and their application to allergic diseases. Therefore, cooperation with the medical profession is essential for the research and development of food products. Thus, further careful evaluation has to be conducted for determining the influence of specific process on the allergens. However, much more research is needed into the causes of food allergy. Such research will help to develop strategies for prevention and management that could improve the health, and quality of life of many people.

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