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Studies on the Human Acceptability of the Watermelon Seed Kernel Products

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Abstract: ***Watermelons have become synonymous with summer. The watermelon seeds can be a quite frustrating experience when we are eating the sweet, refreshing fruit and have to pause to take out the tiny seeds scattered in the fruit. So the seeds are thrown away and neglected having no idea of its nutritional value. The objective of the present study is to incorporate the unconventional, cheap, thrown away and locally available watermelon seed kernels into our regular diet for achieving good nutrition. A sensory panel was prepared by selecting 100 people having normal health. They were divided equally into two different sex groups, male and female of 20-40 years respectively. The six new food preparations were given to each member of the panel. They evaluated the organoleptic properties of these products and acceptability of the food products was determined using a 9-point hedonic rating scale.***

Keywords: acceptability, hedonic rating scale, nutritive value, *organoleptic properties*, sensory panel, watermelon seeds (*Citrullus vulgaris*).

1. Introduction

More than one billion people in the world are reeling under the social venom of hunger and against each of 3.4 second, we are losing one hungry child forever. 65 percent of the world's hungry population lives in only seven countries: India, China, the Democratic Republic of Congo, Bangladesh, Indonesia, Pakistan and Ethiopia [1]. This being the world scenario, recently more attention has been focused to recover valuable components from neglected food parts (food "losses", "wastes", "by-products" or "wasted by-products") and recycle them inside the food chain, in an economic and sustainable way. Fruits occupy a part of daily diet of the rich and rarely the poor. But there are many parts of a fruit that are not considered to be edible and are thrown away. One such fruit is watermelon, which is taken by all but the seeds of watermelon are thrown away and generally not included in regular diet. The juice or pulp from watermelon is considered as the edible portion but rind and seeds are discarded as major solid wastes [2]. The fruit has numerous small black seeds embedded in the middle of the flesh. The embryo completely fills the seed. The seeds have sweet and nutritious kernels. Several studies have shown that seeds of *Cucurbitaceae* species are potential sources of nutrients such as protein, minerals and lipids as well as ingredients for native medicine. Watermelon (*Citrullus vulgaris)* seed, whose cultivar name is Sugar baby is one of such sources. "Charmagaz" which is familiar in the sub continental region as a therapeutic agent , is derived from the seed kernels of cucurbit fruits and vegetables such as melon, watermelon, cucumber and gourd [3]. These seeds have been categorized as less familiar foodstuffs in the book 'Nutritive Value of Indian Foods' published by ICMR [4] and from the analysis done by Gopalan et al (2000), it has been revealed that watermelon seeds have high amount of fat (52.6gm/100), considerable amount of protein (34.1gm/100gm), calcium (100mg/100gm), phosphorus (937mg/100gm) in comparison with other oilseeds. 59.64% Linoleic acid [5] and arginine (900mg/ g of N) are present in watermelon seeds. Consumption of *C. vulgaris* seed kernels by male albino rats caused positive effect on growth and beneficial effect on serum lipid profile parameters [6]. An extensive review of literature throws light on the fact that these seeds contain a lot of valuable nutrients and may provide considerable nutritional value to the Indian diet. Defatted watermelon seed flour has been used previously to make food products [7, 8]. This research work is an attempt to acquaint the people with these neglected seeds and to determine whether these seeds can find acceptability among the people and therefore can be included in the diet.

Hence the aims and objectives of the present research are to:

- Prepare some low cost new food products by incorporating this less familiar oilseed, for 100 human subjects.
- Determine the acceptability of those food items across the age groups among both male and female human subjects.
- Calculate the nutritive values of the prepared food items.
- Analyse the costs of the new food items.

2. Materials and Methods

2.1 Sample Collection and Preparation

At first seeds were collected from kitchen waste and washed thoroughly with clean running water. Then the seeds were dried in shade and after drying they were dehusked in a decorticator. The separated seed kernels were collected and grounded in a mixer grinder. Half of the grounded kernels were stored in a dry, clean and air tight container and another half were made defatted by Soxhlet extractor [9]. Defatted sample was also stored in another clean, dry and air tight container.

2.2. Some products made by *Citrullus vulgaris* seed kernels

Six new food products were prepared from grounded watermelon seed kernels and defatted watermelon seed kernel powder by mixing the ingredients in suitable proportions.

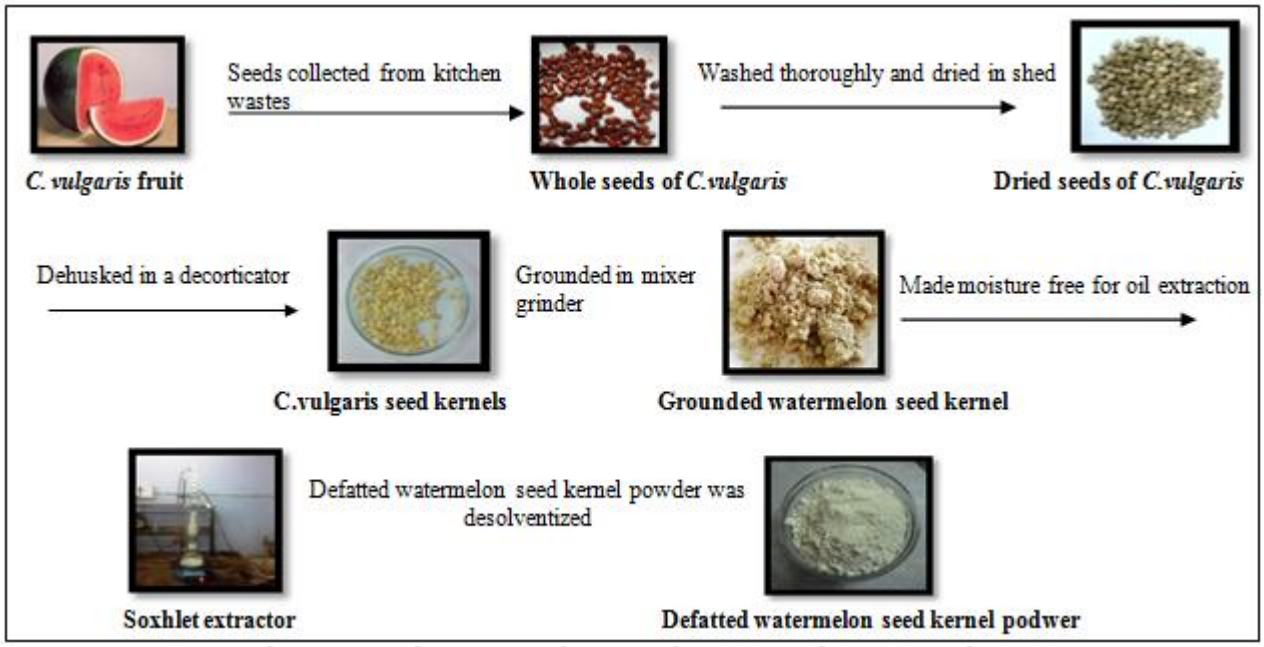

Figure 1: Flow chart of sample preparation

Table 1: New Trial Food Products

Items	*Ingredients*	*Amount*
Item-1: Roti	Wheat	50 gm
	Defatted watermelon seed powder	50 gm
	Salt	According to taste
Item-2: Potato Curry	Potato	88 gm
	Defatted watermelon seed powder	8.8 gm
	Mustard oil	3 ml
	Onion	30 gm
	Green chilly	2 pcs
	Sugar and salt	According to taste
Item-3: Sandesh	Grounded watermelon seed kernel	77 gm
	Coconut	10 gm
	Sugar	13 gm
Item-4: Laddu	Grounded watermelon seed kernel	72 gm
	Sugar	28 gm
	Defatted watermelon seed powder	60gm
	Potato	30gm
Item-5: Pakoda	Mustard oil	10ml
	Onion	3gm
	Garlic, Ginger	3gm
	Green chilly	1.5gm
	Salt	According to taste
Item-6: Toffee	Grounded watermelon seed kernel	25gm
	Jaggery	37.5gm
	Tamarind	37.5gm

2.3. Sensory Evaluation

Sensory evaluation of the food products for their acceptability was done by each member of the panel. The score card based on the 9 point Hedonic Scale was used for sensory evaluation on the basis of evaluation of attributes like appearance, texture, taste, odour, flavour and colour [10].

Table 2: Age-Wise Distribution of Subjects Based On Sex

Age groups (in years)	Total	Male	Female
20-40	100	50	50

2.4. Nutritive Value and Cost Analysis

Proximate analysis i.e. protein, fat, carbohydrate and energy content of the prepared food products were calculated based on the nutritive values of the ingredients given in the book of 'Nutritive value of Indian foods'(C. Gopalan). Proximate analysis of defatted watermelon seed kernel powder was done by A.J Lakshmi & P.Kaul [11] and calculation of protein, fat, carbohydrate and calorie content of the enriched food products were done by referring those values. The costs of the products (100gm/serving) were calculated on the basis of price of 1Kg raw ingredients at the prevailing market price. The price of grounded watermelon seed kernel and defatted watermelon seed kernel powder were considered as zero as we have collected it from kitchen waste.

2.5. Statistical Analysis

The data obtained from sensory evaluation were statistically analyzed by using SPSS software version 16.0. Standard deviation of the overall acceptability and sensory attributes of the food products among male and female subjects were also determined.

3. Results and Discussions

Table 3: Nutritive Value of Food Prepared By Mixing Watermelon Seed Kernel (100gm/Serving)

Products name	Carbohydrate (gm)	Protein (gm)	Fat (gm)	Energy (kcal)
Roti	51.68	36.7	1.33	365.28
Potato curry	22.66	6.8	3.16	146.25
Sandesh	18.23	26.95	46.73	601.5
Laddu	31.07	24.56	37.87	493.95
Pakoda	27.16	37.25	10.6	352.83
Toffee	62.04	9.84	13.23	406.76

Item1 (Roti) is rich in carbohydrate and incorporation of 50% defatted watermelon seed kernel powder made this product enriched in protein. It is a calorie dense food item. So item1 is suitable for underweight person. As this product contains very less fat (1.33g /100g) so it can be recommended in fat restricted diet and can be given to patients suffering from chronic pancreatitis and gall bladder disease. Item2 (Potato curry) is not nutritionally superior to Item 1 but it also provides moderate amount of calorie, protein and carbohydrate and some fat too. Item 3 (Sandesh) not only provides appreciable amount of carbohydrate and calorie, but also provides large amount of fat and moderate amount of protein. Addition of coconut makes this item tastier and provides potassium. It is very suitable for underweight patient. Item4 (Laddu), as a sole watermelon seed product, contains good amount of carbohydrate, protein and fat and so it could be a good choice for children and adolescents of both sex groups. Item5 (Pakoda) was made up of defatted watermelon seed powder, so it contains moderate amount of carbohydrate, appreciable amount of protein and also provides calorie. Most of the people have a common perception that high fat intake is linked to coronary heart disease and atherosclerosis, but this product contains mustard oil which could contribute to the lower risk of Ischemic heart disease among Indians [12]. This item also contains garlic, ginger and onion that have lots of medicinal values [13]. Item6 (Toffee) provides good amount of carbohydrate and moderate amount of fat too. Addition of jaggery made this product a good source of iron so it can be helpful for anaemic patient [4].

Table 4: Overall Acceptability Based On Sensory Scores Of Six Different Food Products Among Male And Female Subjects

Name of the food products	Female subjects (n=50)	Male subjects (n=50)
	mean ± SD	mean ± SD
Roti	43.88 ± 5.95	47.56 ± 3.94
Potato curry	47.28 ± 4.83	48.32 ± 3.38
Sandesh	46.34 ± 4.82	48.24 ± 4.85
Laddu	36.68 ± 7.90	40.76 ± 8.86
Pakoda	45.72 ± 6.60	47.36 ± 5.53
Toffee	47.42 ± 6.33	50.86 ± 3.44

Figure in the parenthesis indicates number of human subjects in each group.

Among both male and female subjects Toffee (Item-6) was highly accepted and Laddu (Item-4) was least accepted. The reasons behind this kind of acceptability variation among the 6 products will be clarified from Table-5.

Table 5: Item Wise Interpretation of Sensory Attributes Based On 9-Point Hedonic Rating Scale Applied To Feedback Provided By Respondents of Both Sexes

Sensory attributes	Item-1 (Roti) Mean ± SD	Item-2 (Potato curry) Mean ± SD	Item-3 (Sandesh) Mean ± SD	Item-4 (Laddu) Mean ± SD	Item-5 (Pakoda) Mean ± SD	Item-6 (Toffee) Mean ± SD
General appearance	7.61 ± 0.94	8.1 ± 0.93	8.07 ± 0.89	7.14 ± 1.58	7.8 ± 1.14	8.1 ± 1.19
Texture	7.77 ±1.00	8.09 ± 0.91	7.82 ± 0.92	7.17 ± 1.42	7.72 ± 1.14	8.14 ± 1.06
Taste	7.38 ± 1.30	8.02 ± 0.86	8.03 ± 0.88	6.02 ± 1.90	7.63 ± 1.36	8.31 ± 1.03
Odour	7.35 ± 1.35	7.81 ± 1.01	7.64 ± 1.00	5.86 ± 2.00	7.56 ± 1.25	8.12 ± 1.03
Flavour	7.33 ± 1.25	7.92 ± 0.90	7.89 ± 1.02	5.77 ± 1.99	7.68 ± 1.17	8.2 ± 1.15
Colour	7.91 ± 0.97	8.07 ± 0.89	7.83 ± 0.96	7.03 ± 1.35	7.7 ± 1.21	8.16 ± 1.08

General appearance, texture, taste, odour, flavour and colour of Potato curry (Item-2), Sandesh (Item-3), Pakoda (Item-5) and Toffee (Item-6) were "liked much" by the respondents. Due to the addition of spices in Potato curry (Item-2) people were not able to identify any change in the item for the incorporation of defatted watermelon seed powder. But, many of them asked whether it was "ALU POSTO" (potato curry made with poppy seeds), a famous Bengali cuisine

item. It may be due to the similarity of taste and texture of defatted watermelon seed powder with that of poppy seeds. People can identify the taste of grounded watermelon seed kernel in Sandesh (Item-3) and reported that it tastes like nuts. Again due to the addition of spices in Pakoda (Item-5), people were not able to identify any change in the item for the incorporation of defatted watermelon seed powder and reported that it tasted like normal "ALU TIKKA". Due to the sweet, sour and spicy taste of Toffee (Item-6) maximum people reported it, as the best item. General appearance, texture and colour of Roti (Item-1) were "liked much" whereas taste, odour and flavour were "liked moderately" by the respondents. In case of Roti (Item-1) maximum subjects reported that all the sensory attributes were same as that of normal Roti of wheat flour. Some told that after eating the chappati they got some flavour but that was not bad at all. General appearance, texture and colour of Laddu (Item-4) were "liked moderately" whereas taste, odour and flavour were "slightly liked" by the respondents. Slightly burnt flavour develops in laddu during its preparation which might be the reason of its deviation from other products based on the scoring of the respondents. Differences of opinions were observed in case of taste, odour and flavour of laddu among the people that has been revealed from the values of standard deviation, which is comparatively more than any other product.

Table 6: Material Cost of the Products Prepared By Incorporating Watermelon Seed Kernel (100gm/Serving)

Name of the products	*Price of the products (Rs.)*
Roti	1.15/- (approx.2/-)
Potato curry	3.23/- (approx. 4/-)
Sandesh	1.83/- (approx. 2/-)
Laddu	0.90/- (approx. 1/-)
Pakoda	1.81/- (approx. 2/-)
Toffee	4.88/- (approx. 5/-)

Cost is very important factor, which affects the marketability of the products and needs to be considered while manufacturing of the food products. It is the basis for price fixation and determining the profit on the cost of production. We collected the seeds of only *C. vulgaris* species from kitchen waste during summer season, as these are not available in the local market of Kolkata. So, the material costs of all the products were very low as we considered the price of watermelon seed kernel as zero.

4. Conclusions

It is concluded that grounded watermelon seed kernels can be successfully incorporated in "Sandesh", "Laddu" and "Toffee" whereas defatted watermelon seed powder can be successfully incorporated in "Roti", "Potato curry" and "Pakoda". On the basis of organoleptic properties, overall acceptability of "Toffee" was found to be best among both the male and female human subjects. General appearance, texture, taste, odour, flavour and colour of Potato curry (Item-2), Sandesh (Item-3), Pakoda (Item-5) and Toffee (Item-6) were "liked much" by the respondents. General appearance, texture and colour of Roti (Item-1) were "liked much" whereas taste, odour and flavour were "liked moderately" by the respondents. Laddu (Item-4) was least accepted among the people. Nutritive values of the prepared products indicate that calorie, protein, fat, carbohydrate, calcium and phosphorus content increased in enriched food products. Costs of all the products were very low.

5. Recommendations

Incorporation of different proportions of watermelon seed kernel in traditional recipes can be encouraged and popularized in order to improve intake of protein, fat, calcium, carbohydrate and phosphorus. These products can also be helpful for providing variety in the daily dietaries in addition to their nutritional benefits and the defatted watermelon seeds powder can be used out of season as well. The nutritional well-being of a population is a reflection of the performance of its social and economic sectors but, even after tremendous advancement in the field of science and technology in last few decades, people suffer from chronic hunger due to low purchasing capacity. Thus incorporation of this unconventional, thrown away and locally available edible oilseed kernel in different food products can impart health and nutritional benefit to those vulnerable populations and here is the social importance of the research work.

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