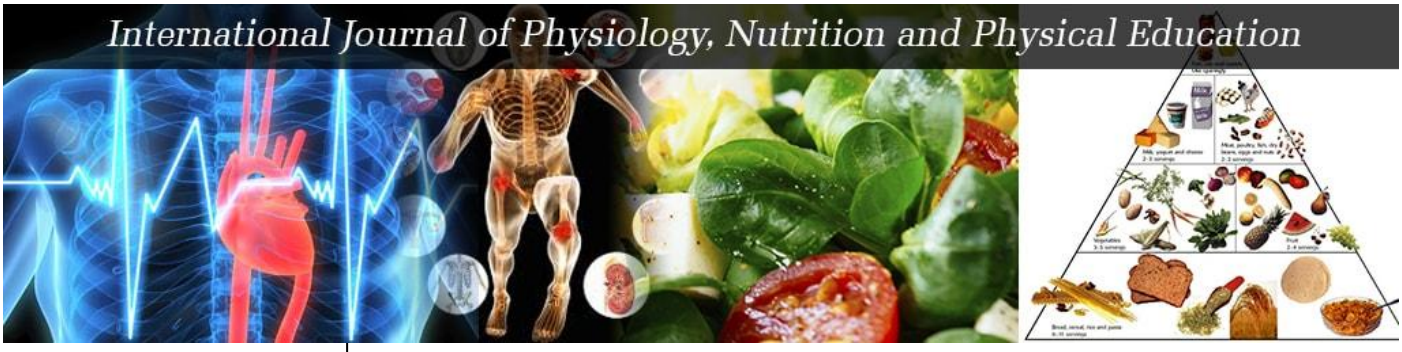

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Development of incorporation of popped nutria-millets in Nutripatakha namkeen for malnourished children

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Abstract
The present study was focused to explore nourishing potential of finger and pearl millets as well as food product development for malnourished children with cost effectiveness. Finger and pearl millets have potential to fight deep rooted malnutrition. Namkeen is popular snack food and loved by children very much. An attempt has been made ready to eat food named Nutripatakha namkeen incorporated by popped finger and pearl millets the range of 2 to 8%. Nutripatakha namkeen enriched with 8% incorporation of popped finger and pearl millets showed good sensory acceptability with mean scores of 8.2±0.61 compare to standard non-significantly. Further result showed that increased value of nutrients in variant C such as energy (381.93 Kcal), protein (14.4048 g/100g), iron (8.668 mg/100g) and calcium (105.706 mg/100g). So, nutripatakha namkeen could be best option for malnourished children with cheap in cost and easy availability of millets.

Keywords: finger millet, pearl millet, malnourished children, sensory evaluation

1. Introduction
In developing countries, malnutrition develop in children as well as chronic under nourishment, deficiency of micronutrients called "hidden hunger" especially rampant in India, need to introduce nutritionally inadequate complementary foods. In this time food must be formulated nutritionally energy-rich, easily digestible and functional food with easily available and low cost to promote optimization of the body for future prospective. To obtain this aim, we must be use local, seasonal, low cost raw food ingredients having rich nutritional and functional properties such as cereals and millets, pulses and dairy materials. Millets can be called as "poor man's crop". India is considered as hub of minor crops like millets. Commercial processing of these locally grown grains into valuable foods and beverages can be an important driver for economic progress in developing countries. Millets have great potential to broadening genetic diversity of food basket and facilitating to boost food and nutritional security [12].

Millets are sixth highest cropping in world agricultural production with characterization of drought-resistance, short growing seasons, resistant to pests and diseases [5]. It has easy storability under ordinary conditions called as 'famine reserves' and due to their nutritional contribution referred as nutria-cereals/nutria-millets [14] or nutricereals [4]. Millets observed as nutritious and health beneficial food grains and help in management of disorders. Limited utilization of staple food at household level occurred due to lack of knowledge and ignorance. Innovative millets processing technologies are helping tool to provide easy-to-handle, ready-to-cook, ready-to-eat, safe products and meals at a commercial scale to feed large populations in urban areas. Food processing methods helps to make meal more attractive in appearance, consistency, flavor, taste, verities as well as making the food safe and increase shelf life with qualitatively changes in the nutritional value of the food due to decreasing anti-nutrients and enhance the availability of nutrients. Popping improve the carbohydrate and protein digestibility due to inactivation of some enzyme and its inhibitors. It improves the appearance, color, taste and aroma of popped food products. Finger millet is very good source of variety of phenolic compounds which may have many health benefits [6]. The main polyphenols are phenolic acid and tannins while flavonoids are present in small quanties [8]. Polyphenols has been known to impart in good health and therapeutic effects.

Pearl millet has high level of calcium, iron, zinc, lipids, and amino acids [18] such as lysine, tryptophan, threonine and fatty acid like omega-9, omega-6 and omega-3 fatty acids. The phytochemicals like tannins, phytates [15] act as antioxidant properties. It has low glycemic index and small amount of flavonoids.

Namkeen are sweet-salted and popular afternoon snack consumed with tea/coffee generally. It can be stored for few weeks in air tight container safely. It is easily carry from one place to another place. For nutritional enhancement of Nutripatakha namkeen, we used popped finger and pearl millets. In addition, roasted channa, rice flex, raisins, sesame seeds and ground nuts were also used to enrichment of energy, protein, calcium, iron and vitamins.

2. Material and methods

Finger and pearl millets were purchased from local market of Jaipur, Rajasthan.

2.1 Preparation of processed forms

2.1.1 Whole raw finger millet flour (WRFMF) and Whole raw pearl millet flour (WRPMF)

Finger and pearl millets were thoroughly cleaned, remove foreign material and dirt. Thereafter, they were sundried and ground into fine flour or powder in a mixer and stored separately.

2.1.2 Popped finger millet flour (PFMF) and Popped pearl millet flour (PPMF)

Another portion of finger and pearl millets were popped and after cooled down, ground in mixer into powder form and stored separately for analysis.

2.2 Proximate analysis

Chemical analysis such as moisture [1], Ash [17], Fat [17], Crude fiber [17], Protein [16], Total carbohydrate [17], Calcium [19], Iron [17], Phosphorus [19], Vitamin C [16] were done for raw and popped samples of finger and pearl millets.

2.3 Preparation of Nutripatakha namkeen

Nutripatakha Namkeen is multi-flavor, easy to carry and highly demandable snack. Three variants of Nutripatakha Namkeen are developed from incorporation of whole popped finger and pearl millets each at 2, 4 and 8% respectively. Standard was without incorporation of millets. Nutripatakha namkeen was prepared with mixing of 20g of roasted Bengal gram, 20g rice flakes, 8g Niger seeds, 15g ground nuts, 5g gond katira, 11g makhane and 5g raisins. Standard was prepared with puffed rice and level was decreased in three variants variants A, B and C respectively.

2.4 Sensory analysis

2.4.1 Nine Point Hedonic Test [2]

In this method, the developed foods were placed near to twenty panelists to evaluate for acceptability at nine point hedonic test. The panelists were judged the acceptability and measure the pleasurable and unpleasurable experiences ranging from 'like extremely' to 'dislike extremely' of the food products. The parforma was carried out 1 to 9 scores, the members were asked to give score to the new foods on the bases of hedonic scale for appearance, color, texture, taste, flavor, after taste and overall acceptability. Performa were collected and resulted were documented.

2.5 Proximate analysis of Nutripatakha namkeen

Nutripatakha namkeen was subjected to proximate analysis such as energy, protein, fat carbohydrate, iron and calcium by above mentioned methods.

2.6 Statistical Analysis

All values as expressed as mean ± standard deviation. Student's t-test also applied on data. Statistical significance was declared at $P \geq 0.05$ Non-significance difference, $P \leq 0.05$ Significance difference.

3. Results and Discussion

Table 1 shown the proximate in raw and popped finger and pearl millets such as moisture content of WRFMF and WRPMF were calculated and found to be similar with other studies and fall within the range of 11.2 to 13.7 g/100g [8]. Popping treatment reduced the moisture content significantly to 3 to 5% that increased shelf life of popped millets [22]. Popping caused slight reduction in total ash content in sorghum reported [20]. Millet oil could be a good source of natural oil rich in linoleic acid and tocopherols [11]. During popping, fat content was decreased significantly. It may be due to lipolytic enzymes are denatured [9]. Value for crude fiber contents of WRFMF and WRPMF were found to be similar with other studies and fall within the range of both millets 3.5-9.0 and 2.1-12.19 g/100g respectively [13]. Protein content of the WRFMF and WRPMF were found to be in agreement with previous data and reported in the range of 7.1-8.2 g/100g and 11.8-14.8 g/100g [7]. The effect of popping (increased significantly) on protein content of millets [23]. The mean values of carbohydrate content in popped samples were found to be increased significantly similar as observed by different studies [3]. Popping process improved the bioaccessibility of iron in finger millet [21]. As per results of the study, popping caused calcium content to significantly decrease and increase the iron contents in millet and it is in league with various studies [10] shown in Table 2.

Table 1: Comparison of major nutrients in raw and popped finger and pearl millets

Parameters	WRFMF	WRPMF	PFMF	PPMF
Moisture	13.1±0.10	12.4±0.40	12.2±0.20^{s}	10.9±0.28^{s}
Ash	2.8±0.17	2.3±0.10	2.9±0.08^{ns}	2.5±0.11^{ns}
Fat	1.3±0.20	5.0±1.00	0.6±0.15^{s}	3.3±0.20^{s}
Crude Fiber	3.5±0.10	2.1±0.05	2.7±0.05^{s}	1.8±0.05^{s}
Protein	7.1±0.20	11.1±1.10	8.1±0.20^{s}	12.9±0.05^{s}
CHO	71.8±0.20	67.5±0.36	75.7±0.98^{s}	71.8±0.90^{s}

^{S} Significant, ^{ns} Non-significant

WRFMF-Whole raw finger millet flour, WRPMF-Whole raw pearl millet flour, PFMF- Popped finger millet flour, PPMF-Popped pearl millet flour.

Table 2: Mineral and vitamin C analysis of raw and popped finger and pearl millets

Parameters	WRFMF	WRPMF	PFMF	PPMF
Calcium	342.4±1.36	41.2±0.57	338.3±1.00^{s}	39.9±1.34^{s}
Iron	3.7±0.06	8.0±1.20	5.1±0.10^{s}	9.8±1.50^{s}
Phosphorus	280.1±1.23	298.3±1.00	282.1±1.10^{ns}	301.2±2.10^{ns}
Vitamin C	0.04±0.01	0.01±0.00	0.0±0.00	0.0±0.00

^{S} Significant, ^{ns} Non-significant

WRFMF-Whole raw finger millet flour, WRPMF-Whole raw pearl millet flour, PFMF- Popped finger millet flour, PPMF-Popped pearl millet flour.

Nutripatakha Namkeen is multi-flavor, easy to carry and highly demandable snack. Three variants of Nutripatakha Namkeen are developed from incorporation of whole popped finger and pearl millets each at 2, 4 and 8% respectively. Acceptability evaluation scores of Nutripatakha Namkeen are shown in Table 3 and Figure 1. From the scores of standard and all variants for each attribute, it is clear that variant A is most acceptable with an overall acceptability score of 8.2±0.61 and standard is next to it with an overall acceptability score of 8.1±0.91. Variant C is placed third with an overall acceptability score of 8.0±0.79 and variant B is least acceptable with an overall acceptability score of 7.9±0.75. There is a non-significant difference ($P \geq 0.05$) between standard and variant A. In terms of appearance, standard is preferred most followed by variant A, B and C respectively. Colour wise preference has followed the same pattern as that of appearance. Texture of variant B has been given the rank one by the assessors. Standard has obtained the second acceptability score of texture attribute followed by Variant A and Variant C. Standard is the most acceptable sample pertaining to the taste attribute followed by variant A, B and C. Standard and variant A, both samples got the first rank with same mean scores for flavour attribute. Variant B is preferred next to them. Variant C is least acceptable. Likeability of variant a stood first for after taste attribute followed by Standard, variant B and variant C. In conclusion, Standard was most acceptable in terms of other attributes (appearance, colour, texture, taste and flavour) compare to standard and three variants.

Table 3: Sensory evaluation of Nutripatakha namkeen

Attribute	Standard	Variant A	Variant B	Variant C
Appearance	8.2±0.83	8.1±0.71	8.05±0.88	8.0±0.91
Colour	8.25±0.78	8.1±0.71	8.0±0.91	7.7±0.73
Texture	8.3±0.73	8.05±0.68	8.25±0.85	7.8±083
Taste	8.35±0.81	8.2±0.61	8.15±0.74	8.1±0.85
Flavor	8.1±0.91	8.1±0.78	8.0±0.56	7.9±0.71
After taste	8.15±0.87	8.2±0.69	8.1±0.71	8.0±0.72
Overall acceptability	8.1±0.91	8.2±0.61^{ns}	7.95±0.75	8.0±0.79

^{S} Significant, ^{ns} Non-significant, S= no incorporation of Millets, variant A=02% PFM whole +02% PPM whole, variant B=04% PFM whole +04% PPM whole, C=08% PFM whole +08% PPM whole

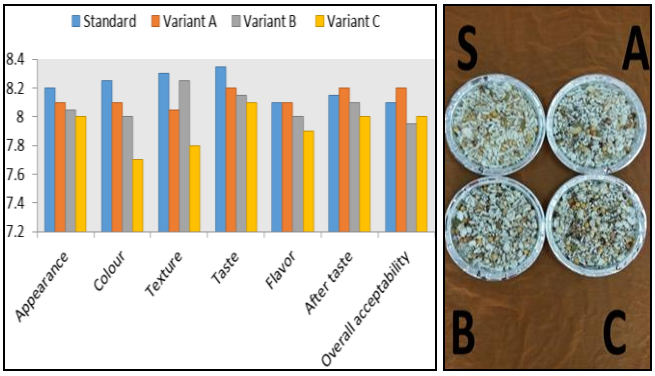

Fig 1: Sensory acceptability of standard and different variants of Nutripatakha namkeen

Table 4: Effect of incorporation of popped finger and pearl millets on nutrients of Nutripatakha namkeen

Variants	Energy (Kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Iron (mg)	Calcium (mg)
Standard	378.8165	13.92	10.4615	57.305	8.532	79.13
Variant A	379.5965	14.0412	10.5361	57.31	8.566	85.774
Variant B	380.3765	14.1624	10.6107	57.316	8.6	92.418
Variant C	381.9365	14.4048	10.7599	57.328	8.668	105.706

Nutrients such as energy, protein, fat, carbohydrate iron and calcium contents of Nutripatakha namkeen incorporated with popped finger and pearl millets were comparable with standard represents in Table 4. Nutripatakha namkeen with added popped finger and pearl millets varied in protein, fat, iron and calcium. An increase in protein content (14.40%) was observed when added 8% of popped finger and pearl millets compare to standard (13.92%). Thus, incorporation of these popped millets resulted increases in protein content. Standard Nutripatakha namkeen contained 8.53 mg/100g of iron and 79.13 mg/100g of calcium. Nutripatakha namkeen prepared with 8% had higher in minerals (iron 8.66 mg/100g and calcium 105.70 mg/100g). Results shown that remarkable increases in mineral content of popped millets incorporated Nutripatakjha namkeen compare to standard.

4. Conclusion

Present study revealed that popping process increased nutrients significantly such as protein, iron and calcium. Popping is a traditional method of processing, simple and least expensive method; prepare ready to consume cereal foods and process of complete loss of birefringence characteristics of starch granules. Sensory evaluation of Nutripatakha namkeen revealed that incorporation of 2% popped finger and pearl millets have good overall acceptability compare to standard with non-significantly. In terms of sensory attributes such as appearance, colour, texture, taste, flavour and after taste showed acceptable acceptability. Nutrient analysis of popped finger and pearl millets incorporated Nutripatakha namkeen shown enhancement of nutrients and have good potential to fight with malnutrition in children.

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