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Nutririch millet (Finger millet) and Legume (Macrotyloma uniflorum) in developing Ready-To-Eat (RTE) food

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ABSTRACT

The proposed article is envisaged in developing RTE foods by effective use of underutilized Nutri-cereals (millets) and legumes which focuses on the functional, rheological and nutritional aspects of millets and legumes used in formulating RTE foods. Further, it also highlights the significance of their consumption and in formulating extruded food. In this study, an attempt has been made to develop nutririch RTE food by incorporating legume with millets. Millet (Finger millet) was blended along with corn and wheat in the proportion of 0:100, 25:75, 50:50 and 100:0. Legume (Macrotyloma uniflorum) flour was added at the rate of 10, 20, 30 and 40 percent. Among these levels of trails 25:75 (finger millet: corn-wheat) with 10 percent legume was awarded highest acceptability score of 8.30 compared to all other samples resulting with significantly highest protein percent (12.25%) compared to control (11.05%). The rheological properties such as hardness, crispiness, gumminess, and chewiness were observed to be 718.10N, 28 numbers of peaks, 138 and 23.62 respectively. Similarly, functional properties namely Expansion ratio of 3.31, Water absorption index of 6.14 g/100g, Water solubility index of 3.52 g/100g, the water holding capacity of 142.55 g/100g and Oil holding the capacity of 68.18 g/100g respectively was observed for millet and legume-based RTE food.

Keywords: *Millets (Finger millet), Macrotyloma uniflorum (Horse gram), RTE food, Rheological and functional attribute of RTE food*

1. INTRODUCTION

The role of Ready to eat (RTE) foods in a balanced diet has been recognized for many years. In addition to providing an important source of vitamins and minerals, breakfast foods are also potentially important sources of antioxidants and many health benefits breakfast cereals are relatively inexpensive, nutrient-dense, and convenient foods, which can be recommended to form part of a healthy balanced diet. Their regular consumption can help ensure an adequate nutrient intake. Recently, a transformation from traditional recipes to RTE food has been developed utilizing millets (Popuri and Rao, 2016).

Millet is a cereal crop plant belonging to the grass family found in arid and semiarid regions, the term "millet" is referred to several types of small-seeded annual grasses belonging to species under the five genera in the tribe Paniceae. Millets belong to five genera: *Penissetum, Eleusine, Setaria, Panicum, and Paspalum*. Finger millet *(Eleusine coracana*) represents a staple food for a large segment of the population. It is one of the ancient millet crop cultivated in several regions of India. It ranks sixth in production after wheat, rice, maize, sorghum and bajra in India. Finger millet contains 72 % carbohydrate, 7.30 % protein, 4.30% fat, 8.0% crude fiber and 3.30 % minerals (ICAR, 2016).

Underutilized legumes are an important group of crops which has special significance in subsistence farming and nutritional security of resource-poor masses in developing countries. One such legume is Horse gram which is largely cultivated, in dry areas of Australia, Burma, India, and Srilanka, mainly for animal feed. It is also used as a vegetable in India and is known as the poor man's pulse crop in southern India. Among underutilized legumes, Horse gram (*Macrotyloma uniflorum*), family Fabaceae is one of the minor or lesser known neglected legume mainly cultivated in Asian and African countries as a dual-purpose crop. Horse gram has been recognized as a potential source of protein and other nutrients. Horse gram seed contains carbohydrate (57.2%), protein (22%), dietary fiber (5.3%), fat (0.50%), calcium (287mg), phosphorous (311mg), iron (6.77mg) and calories (321 Kcal) as well as vitamins like thiamine (0.4mg), riboflavin (0.2mg) and niacin (1.5mg) per 100g of dry matter (Shashijain *et al*., 2012 and Bolbhat and Dhumal, 2012). Horse gram has excellent therapeutic properties and traditionally used to cure kidney stones, asthma, bronchitis, leukoderma, urinary discharges, heart diseases, piles etc. Besides, it also possesses anti-diabetic, anti-ulcer activity and also helps in the dietary management of obesity due to the presence of beneficial bioactive compounds (Bhartiya *et al*., 2015).

2. METHODOLOGY

The moisture content of all the ingredients and samples is estimated as per IS: SP 18(Part XI), 1981. The total protein content of the dried samples of ingredients as well as final RTE food is computed by estimating total nitrogen by the Micro kjeldahl method as per procedure given in IS: SP 18(Part XI), 1981. Fat content is estimated by ether extract method as per the procedure of IS: SP 18(Part XI), 1981. Total ash content of the developed RTE food is analyzed as per the procedure of IS: SP 18(Part XI), 1981.

The crude fiber of the sample is estimated by using moisture and fat-free samples and expressed as g/ 100g or percent of the samples used as per AOAC (1984). The textural properties of extrudates were measured using Texture Analyzer (TA-XT2, Stable Microsystems, Surrey, UK) fitted with 49 N load cell and 36 mm diameter cylinder probe with pre and post-test speed of 1mm/s and 10 mm/s respectively. The calculations were done by 'Texture Expert' software attached to the texture analyzer. Sensory evaluation of samples is carried out by a panel of 5 in-house judges by providing a 9-point hedonic scale.

Functional Properties such as Expansion Ratio (ER) was estimated as per (Fan *et al*., 1996). Water Solubility Index (WSI), Water Absorption Index (WAI) Water Holding Capacity (WHC) is determined by the method of Anderson (1982a).

3. PREPARATION OF LEGUME FLOUR

The ingredients used in the formulation of nutricereal based legume incorporated RTE food are preprocessed by standard protocol before used in the formulation. Millet malt flour was prepared as per the procedure described by Suresha (2016) and control sample was prepared as per the procedure followed by Harini *et al.*, (2018). The malted horse gram flour preparation: The horse gram grains are cleaned and soaked in potable water for 24h with a grain to water ratio of 1:3. The soaked grains are spread on a muslin cloth and allowed for germination at a temperature of 37°C for 24h. The sprouted grains were dried at 37°C. The dried grains are subjected to roasting followed by milling in a domestic flour mill to get the malted horse gram flour.

4. OPTIMIZATION OF MALTED HORSE GRAM FLOUR LEVEL IN NUTRICEREALS BASED RTE FOOD

The proportions of finger millet and corn-wheat (25:75) were blended with malted legume (Horse gram) flour @ 10, 20, 30 and 40 % levels. The resultant product was further admixed with 20 per cent sugar maintaining 22 per cent moisture and oil fried at 110 °C. The developed product was subjected to sensory evaluation (9-point hedonic scale) by serving to a panel of 5 judges in order to select the optimum levels of malted horse gram in the nutricereal based RTE food. The enriched RTE food product blended with millet and legume was subjected to Physio-chemical, Functional, Rheological and Sensory studies.

5. RESULTS AND DISCUSSION

5.1 Effect of supplementation of Horse gram on the chemical composition of finger millet based RTE food

The RTE food based on finger millet was formulated in order to utilize the most nutritious under-utilized millet (finger millet) and locally grown protein-rich legume (Horse gram) to enhance the nutritional level of RTE food. The horse gram was supplemented to RTE food from 10 to 40 percent. The effect of supplementation of horse gram on chemical composition was studied (Table- 1).

Upon addition of horse gram moisture and mineral content represented non-significant effect. The noticeable difference was observed with fat, protein, crude fiber and carbohydrate content. As observed from the result of an increase in horse gram levels fat content decreased. This is because horse gram contains very low content of fat (0.5%). A tremendous increase in protein content is highlighted for RTE food upon addition of horse gram. The maximum protein content was observed for 40 percent horse gram supplementation with 16.73 percent. This can be attributed to the fact that the horse gram is protein rich and contains 22 percent of protein content (Shashijain *et al*., 2012, Marimuthu and Krishnamurthy, 2013,).

A commendable increase in crude fiber was also observed for RTE food as levels of supplementation of horse gram increased. This can be mainly due to the composition of horse gram which contains high crude fiber profile (5.12%). A decrease in carbohydrate content was noted as levels of addition of horse gram increased which can be attributed to the fact that horse gram contains a low level of carbohydrate (57.10%) thereby decreases the carbohydrate content of RTE food upon supplementation (Sharmila and Athmaselvi, 2017).

5.2 Effect of supplementation of Horse gram on functional properties of finger millet based RTE food

Innovative RTE food from the optimized level of corn-wheat and finger millet was produced. The various levels of horse gram were supplemented at different proportions. Its effect on functional properties was studied (Table-2).

The ER decreased with increase in the horse gram supplementation. The highest ER has observed for 10 percent horse gram incorporation. The commonly observed trend between moisture and ER can be explained on the basis of the lubricating effect of moisture. The reduced viscosity of melt at high moisture trend to reduce the pressure between the differential interior of a growing bubble and atmospheric pressure thus leading to a less expanded product.

WAI is considered as an indicator of the degree of starch gelatinization, representing the amount of water immobilized by the extrudate. WAI observed in the present study varied from 6.57 to 5.46 g/100 g. This can be postulated to high dextrinization. The WSI varied between 3.52 to 4.78 g/100 g. The variation in WSI values might be attributed to composition and preparation of raw material formulations being used. Results from various researchers indicate that higher feed moisture in extrusion process can diminish starch degradation and protein denaturation hence decreases WSI. Results demonstrated the decrease in WHC and OAC of the finger millet based RTE food. This behavior can be explained by the combined effect of composition and heat.
Our findings are consistent with those reported by several authors who found a similar positive trend in the functional properties of RTE food (Sawanth *et al*., 2013; Swapnil *et al*., 2016, Patil *et al*., 2017). Thus, it can be concluded that adding a legume to RTE increases the nutritional and functionality of the product.

5.3 Effect of supplementation of Horse gram on rheological properties of finger millet based RTE food

The hardness, crispiness, gumminess, and crispiness have a positive effect in compelling the textural attribute of RTE food. The horse gram had the significant effect on the rheological attribute of finger millet based RTE food. The increased horse gram supplementation contributed to the hard product which can be attributed to the dependent variable such as moisture, temperature and compositional factors (Table 3).

The compositional effect and various variables like moisture and temperature produced more and crispier product. The increase in temperature (frying) triggers the starch dextrinization, superheating of water and bubble formation which simultaneously produced low ball thickness resulting in a crispier product with low gumminess and chewiness. Several studies conducted by the researchers justify our result. The studies reported by Omwamba and Mahungu (2014) and Patil *et al*. (2017) supports the findings.

5.4 Effect of supplementation of Horse gram on sensory characteristics of finger millet based RTE food

The panels of semi-trained judges were given finger millet based RTE food for evaluation of organoleptic characteristics. The average score recorded by judges was considered and presented (Table 4). The mean scores of sensory evaluations showed that the extruded product prepared from 10 percent of horse gram exhibited higher acceptance (8.30). It was revealed by the score that coarse millet grains and legumes can be successfully blended in the RTE food to produce better acceptable and nutririch product. The studies in the investigation are concord with the results of Patil *et al*. (2017) and Sharmila and Athmaselvi (2017).

6. CONCLUSION

The research was undertaken to explore the possibilities of utilization of the neglected, underutilized minor millets and legumes which are highly nutritious in vitamins, minerals proteins and fiber content with low fat and carbohydrate profile. The nutririch foods with good functionality and rheological prospects are gaining popularity across the globe to meet consumer demand for healthy and nutritious diet. Utilization of millets with legume has great potentiality in meeting the nutritional requirement in the form of RTE food. The developed product contributes to and helps in boosting the marketing of innovative nutririch based RTE food with ease of commercialization.

Table 1: Effect of supplementation of Horse gram on the chemical composition of finger millet based RTE food

Levels of Horse Gram	Moisture	Fat	Protein	Crude fiber	Mineral	Carbohydrate
			Percent			
Control	3.85	4.34^{a}	11.05^{a}	2.47^{a}	2.42	75.87^{a}
10	3.84	3.99^{b}	12.25^{b}	2.75^{b}	2.54	74.63^{b}
20	3.81	3.71^{c}	13.62^{c}	3.08^{c}	2.70	73.08^{c}
30	3.79	3.48^{d}	15.13^{d}	3.43^{d}	2.89	71.28^{d}
40	3.78	3.30^{e}	16.73^{e}	3.81^{e}	3.11	69.27^{c}
CD P ≤ 0.05	NS	0.13	1.15	0.22	NS	0.41

* All values are average of three trails

Table 2: Effect of supplementation of Horse gram on functional properties of a finger millet based RTE food

Levels of Horse Gram (%)	ER	WAI(g/100g)	WSI(g/100g)	WHC(g/100g)	OAC(g/100g)
Control	3.52^{a}	7.09^{a}	2.93^{a}	150.03^{a}	67.00^{a}
10	3.31^{b}	6.57^{b}	3.52^{b}	142.55^{b}	68.18^{b}
20	3.14^{c}	6.14^{c}	4.01^{c}	136.30^{c}	69.16^{c}
30	3.00^{d}	5.77^{d}	4.42^{d}	131.07^{d}	70.00^{d}
40	2.87^{e}	5.46^{e}	4.78^{e}	126.50^{e}	70.76^{e}
CD P ≤ 0.05	0.12	0.21	0.21	3.63	0.72

* All values are average of three trails

ER – Expansion Ratio; WAI-Water Absorption Index; WSI- Water Solubility Index
WHC- Water Holding Capacity; OAC- Oil Absorption Capacity

Table 3: Effect of supplementation of Horse gram on rheological properties of finger millet based RTE food

Levels of Horse Gram (%)	Hardness	Crispiness	Gumminess	Chewiness
Control	711.20^{a}	27^{a}	151.41^{a}	25.51^{a}
10	718.10^{a}	28^{a}	138.00^{b}	23.62^{a}
20	750.21^{b}	30^{b}	125.03^{c}	21.22^{b}
30	785.33^{c}	33^{c}	113.51^{d}	18.33^{c}
40	804.10^{d}	35^{d}	102.26^{e}	15.50^{d}
CD P ≤ 0.05	13.00	1.50	9.20	2.11

* All values are average of three trails

Table 4: Effect of supplementation of Horse gram on sensory characteristics of finger millet based RTE food

Levels of Horse Gram (%)	Colour & Appearance	Body & Texture	Flavor	Overall Acceptability
Control	8.15[a]	8.18[a]	8.18[a]	8.25[a]
10	8.00[a]	8.27[a]	8.22[a]	8.30[a]
20	7.62[b]	7.70[b]	8.03[b]	7.80[b]
30	7.58[b]	7.50[b]	7.42[c]	7.40[c]
40	7.21[c]	7.10[c]	7.44[d]	7.11[d]
CD P ≤ 0.05	1.20	0.30	0.13	0.27

* All values are average of three trails

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