Research Article

Traditional Ready-To-Use Mix for the Food Basket of Calamity Stranded Evacuees – Analysis of Sensory, Nutritional and Storage Parameters

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Abstract

Aftermath of any disaster, food assistance in line with cultural and attitudinal beliefs becomes an important factor to help meet the increased nutrient needs of the stranded evacuees to recover fast. A ready-to-use traditional food *sandah guri* mix of Assam was developed using cooked rice flour, roasted wheat flour and bengal gram flour in different formulations with the skimmed milk powder, jaggery powder, groundnut powder, and raisins. The ready-to-use mix was widely accepted by the sensory panelists and had a high protein (16.23 %), fibre (0.82 %), ash (1.06%), net dietary protein calories percent (NDP cal %) 10.5 %, *in vitro* protein digestibility (87.1 %), lysine (444.7 mg), calcium (206.2 mg), and iron (3.14 mg) along with 60 days of overall acceptability in High density polypropylene and aluminium laminate pouches at ambient temperature. Therefore, it can be concluded that the ready-to-use traditional food *sandah guri* mix can be effectively put into the food baskets of calamity evacuees to meet their increased needs of protein, energy and micronutrients to speed up their recovery from any injury, illness or disease and shock. It will address the cultural competence aspect of food assistance which often gets the least attention.

Keywords: *sandah guri*, ready-to-use, protein, disaster, evacuees

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Introduction

According to the state disaster management authority (SDMA) of Assam, it is located on the unstable tectonic plates of Himalayas making it fall under the seismic zone V, thus, prone to an intensity of moderate to very high earthquake. As a result of tremors after earthquake, sometimes the land suddenly shifts and the incidents of landslides are frequently observed. All the rivers in Assam, particularly, Brahmaputra, receives a heavy rainfall within a short time from June to September, therefore turning into ravaging floods and bringing about a lot of devastation, colossal loss of human lives and damage to property and infrastructure.

Aftermath of any disaster, one of the major aspects of humanitarian assistance consists of food aid which has always remained an indispensable tool when responding to emergency crises [1, 2]. The availability and accessibility of nutritious food with increased shelf life for the stranded evacuees is of immense concern [3] and helps to restore the food security at all levels. Also**,** the nutrient composition of emergency relief foods must have an adequacy with respect to the increased needs of specific nutrients like protein and micronutrients like calcium and iron. Muscle protein is crucially important to recover from injury and illness both for its role in balancing the metabolic needs of other organs and for its reserves of protein for use in energy production [4] and also in healing of wounds. Calcium and iron are needed to compensate for the losses due to bone cracking and blood loss from injury. According to WHO and UNICEF [5], energy needs are usually met through a range of commodities with ample protein content (cereal, blended food, pulses). In line with FAO/WHO technical reports, protein should provide at least 10-12% of total energy. The requirements of a population can be readily satisfied with mixtures of proteins of plant origin e.g. cereals and legumes. Recently, in India, Joint FAO/IAEA programme of nuclear techniques undertook a Coordinated Research Project (CRP) where a product ‘Stuffed Baked Food (SBF)’ was developed for disaster hit victims. It was prepared using fermented multigrain dough which was enriched with 5% saturated fat and was stuffed with roasted chick pea flour; cooked chick pea split and mashed potato with spices and salt [6]. It was based on an ethnic product called *Bati* or *Litti*, which is a regular food preparation in many northern states of India which are disaster prone.

Sometimes, it has been observed that when the food aid does not match with the cultural beliefs of affected population, it gets rejected and often gets wasted thus jeopardizing the state of food security. By applying the cultural competence in food aid and rations, the involved professionals may have a better understanding to address the immediate food needs and other assistance of a diverse population. Providing traditional food of the concerned state helps in its wider acceptance because the stranded population can relate with the food as they have cultural and religious beliefs associated with the food. In some emergency situations, ready-to-eat meals may serve a useful temporary purpose as it removes the necessity to use utensils and other kitchen preparations because sometimes setting up kitchen and then providing aid becomes difficult when the stranded population get stuck in a cut off area from the main routes.

Therefore, in the present study, the traditional product *sandah guri* which is also called as Assamese roasted rice flour porridge generally consumed with curd and jaggery with a storage life of several months was selected for modification to develop more nutritious ready-to-use (RTU) *sandah guri* mix using cereal (roasted rice and wheat) and pulse (roasted bengal gram) combination along with skimmed milk powder, jaggery powder, groundnut powder and raisins. It was further evaluated for the sensory, nutritional and storage parameters to assess its adequacy for inclusion in food baskets of disaster hit victims.

Materials and Methods

Procurement of raw materials

The ingredients like whole wheat flour, rice flour, bengal gram flour as well as other ingredients like, jaggery, skimmed milk powder and groundnut were procured from the local market of Punjab Agricultural University, Ludhiana, Punjab, India.

Ready-to-use mix preparation

Traditional recipe *sandah guri* was standardized and prepared using the blend of cooked rice flour, roasted wheat flour and roasted bengal gram flour in following proportions along with 30 g jaggery powder, 40 g skimmed milk powder, 10 g groundnut powder and 5 g raisins (**Table 1**). The method of preparation of the RTU *sandah guri* mix is detailed in **Figure 1**. After grinding cooked and dehydrated rice flour, roasted wheat flour and bengal gram flour into fine powder, skimmed milk powder, jaggery powder, groundnut powder and raisins are mixed into them and stored in laminate pouches.

Table 1 Standardization of recipe of RTU *sandah guri* mix

Ingredients	Control	T1	T2	T3
Roasted Rice flour(g)	100	-	-	-
Cooked rice flour (g)	-	80	70	60
Roasted wheat flour (g)	-	10	15	20
Roasted bengal gram flour	-	10	15	20
Milk (ml)	50	-	-	-
Skimmed milk powder (g)	-	40	40	40
Jaggery Powder (g)	30	30	30	30
Groundnut Powder (g)	-	10	10	10
Raisins (g)	5	5	5	5

Sensory evaluation

The sensory evaluation of the RTU *sandah guri* mix was carried out by a total of fifteen panelists including five semi-trained panelists from the faculty of department of Food and Nutrition of Punjab Agricultural University with approximate age between 40 to 55 years and ten untrained panelists' who were residents of Assam residing in the Girl's Hostel of Punjab Agricultural University, Ludhiana. The local people of identified state were chosen due to their familiarity with the traditional food of their state. The panel was provided 9- point hedonic scale for attributes like appearance, colour, texture, aroma, taste and overall acceptability [7].

Analysis of nutritional parameters

The RTU *sandah guri* mix was analyzed for protein, fat and ash as per standard AOAC [8] methods and the total carbohydrate content was determined by the method of difference. Energy was determined based on protein, fat and carbohydrate contents. The total calcium, iron and zinc were estimated by Atomic Absorption Spectrophotometer [8]. Lysine content was calculated by the method [9] as modified in [10].

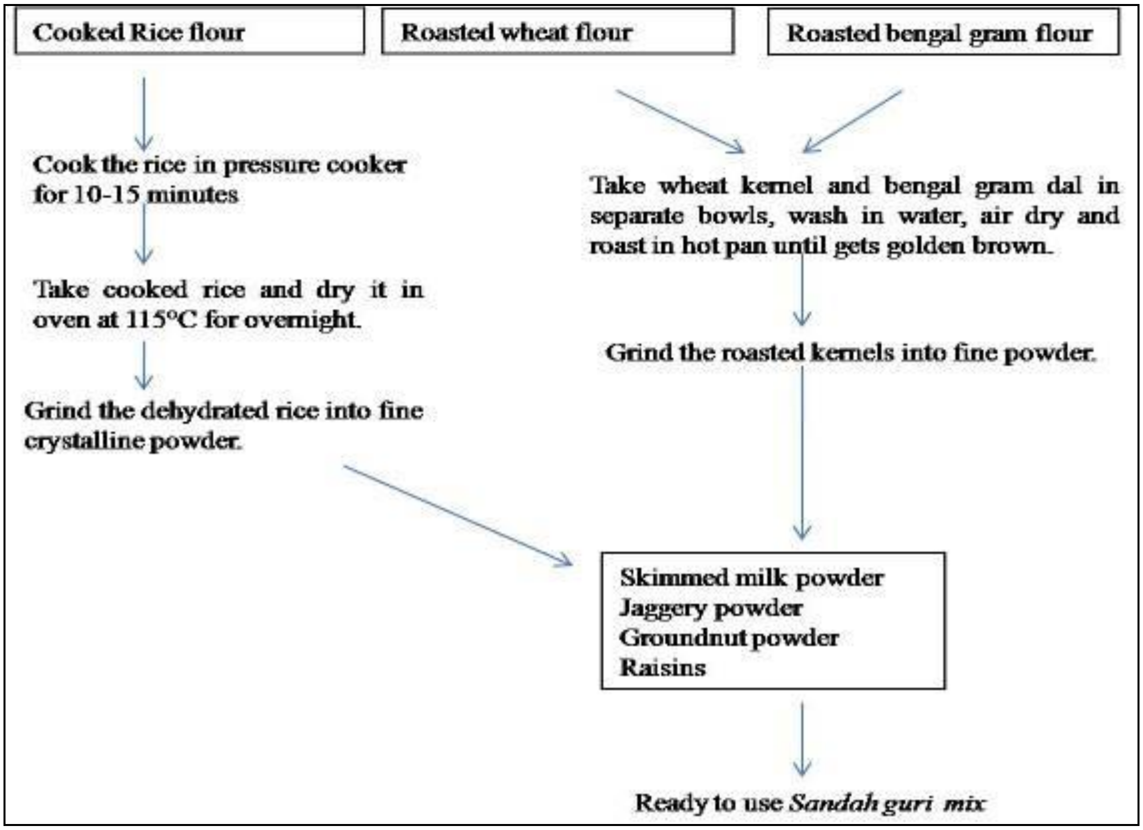

Figure 1 Flow chart for preparation of ready-to-use *mix*

In vitro protein digestibility

In vitro protein digestibility was determined according to the method [11]. Accordingly, 0.5g of dried sample in 250ml conical flask was taken. Added 50 ml of pepsin solution and incubated at 37^{0}C for 24 hours. After that it was neutralized with 30ml of 0.2N NaOH. Then added 50 ml of pancreatin solution and incubated again at 37^{0}C for 24 hours. Enzyme blank was run under the described conditions with the protein sample omitted. A few drops of toluene were added to maintain the aseptic environment in the system. The contents of the flask were centrifuged under high speed and filtered residue was analyzed for nitrogen content by macro kjeldahl method. The digestibility co-efficient of the protein was determined by subtracting the residual protein from the initial protein on the basis of 100g of the sample.

Net Dietary Protein Calories Percent (NDP cal %)

The NDP Cal% is the net dietary protein value expressed as percent of total calories. The chemical score was utilized in calculating the NDP Cal% as it is an indicative of protein value using the method [12]. The chemical score is the ratio between the content of the most limiting amino acid in the test protein to the content of the same amino acid in the reference protein (egg protein) expressed as a percentage. The formula used was as under:

$$\text{Chemical Score (CS)} = \frac{\text{mg of amino acid in 1 g of test protein}}{\text{mg of amino acid in 1 g of reference protein}} \times 100$$

$$\text{NDP Cal \%} = \frac{\text{Protein Calories in the diet}}{\text{Total Calories}} \times \text{Chemical score} \times 100$$

Storage stability

The RTU *sandah guri* mix was packed in two different types of packaging material namely Aluminum laminate and High-density polypropylene (HDPE) pouches. It was then stored in plastic air tight container at room temperature (30±2^{0}C) for two months. Standard AOAC [8] procedures were used to determine changes in moisture content, free fatty acids and peroxide value for fresh and during storage of two months periodically after 0, 15, 30, 45 and 60 days.

The sensory evaluation was also done comparing the difference in colour, appearance, texture, taste and overall acceptability of the ERFs using 9-point hedonic scale.

Results and Discussion

Sensory evaluation

The sensory evaluation of RTU *sandah guri* mix has been shown in **Figure 2**. It was developed at three different levels. Control was prepared using solely roasted rice flour. For Ready-to-use mix, the three formulations were prepared using cooked rice flour, roasted wheat flour and bengal gram flour in the ratio of 80:10:10 (T1), 70:15:15 (T2) and 60:20:20 (T3), respectively.

All the three formulations of RTU *sandah guri* mix which were modulated from traditional food *sandah guri* were acceptable to the panelists. It was observed that with increase in cooked rice flour, roasted wheat flour and bengal gram flour, the mean scores of appearance, color, texture, taste and flavor increased significantly ($p<0.05$) in T3 formulation of RTU *sandah guri* mix.

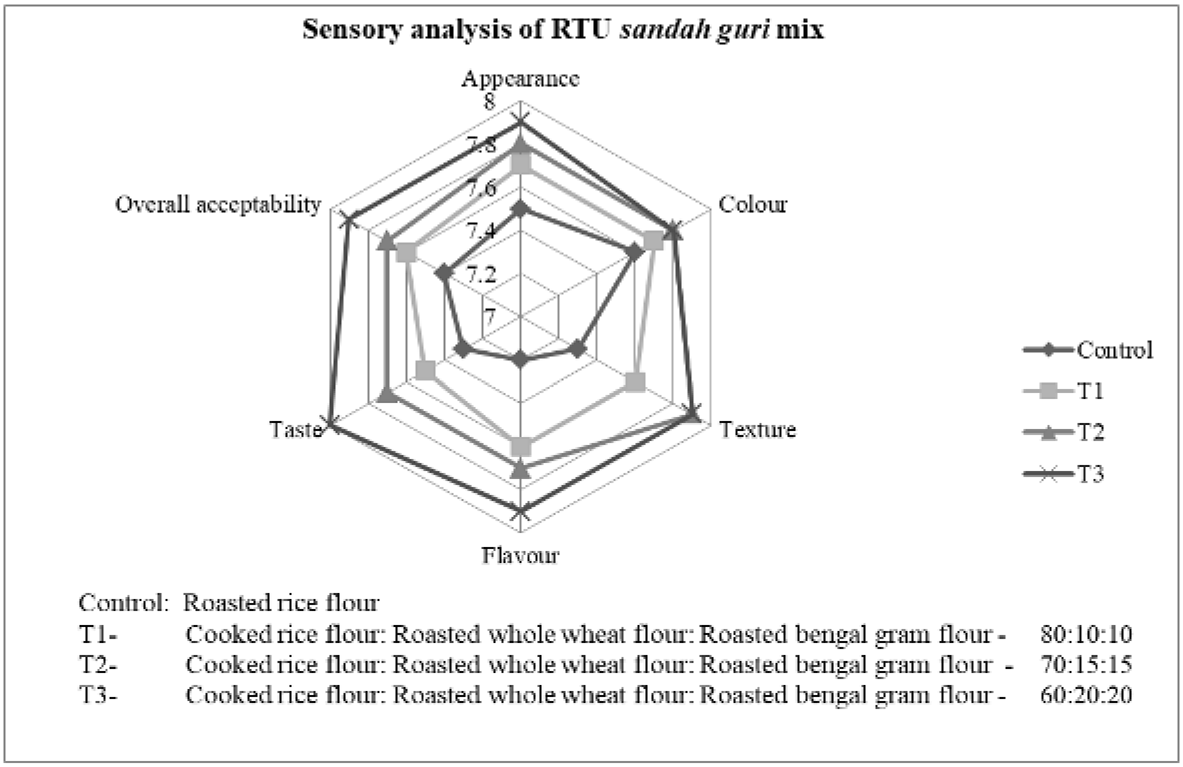

Figure 2 Sensory analysis of RTU sandah guri mix

Overall acceptability was determined on the basis of scores obtained from the evaluation of color, texture, taste, and flavor of the RTU *sandah guri* mix. Although there was no significant difference in the appearance and colour of the different formulations, the scores for texture reported an increased trend with increased composition of wheat flour and bengal gram flour. Similar trend was also seen in the scores of flavor and taste. The mean score regarding overall acceptability of RTU mix revealed that T3 formulation got the maximum score of 7.9. The higher acceptance of the treatments with roasted wheat flour and bengal gram flour can be attributed to the release of flavor compounds by maillard reaction (reaction of amino acid and reducing sugar) and caramelization during roasting of wheat and bengal gram which are good source of carbohydrates and protein. It has been observed that roasting is a common process applied for nuts, seeds and pulses to enhance flavor, desired colour and crunchy texture [13, 14] and this could be the reason for increased acceptability of RTU *sandah guri* mix with bengal gram and groundnut as its constituents.

Nutritional Parameters

The nutritional composition of traditional food RTU *sandah guri* mix is given in **Table 2**. The moisture content of RTU *sandah guri* mix increased gradually from 3.25 to 3.41% when roasted wheat flour and bengal gram flour was supplemented in cooked and dehydrated rice flour. A study [15] reported that increase in moisture content has been associated with increase in the fibre content which might have increased in RTU *sandah guri* mix on addition of wheat flour and bengal gram flour. A significantly ($p \leq 0.01$) higher crude protein content was observed in RTU *sandah guri* mix in comparison to control (16.23 *vs* 10.45 g).

Table 2 Nutrient composition of RTU *sandah guri* mix (g/100 g)

Parameters	Control	RTU *sandah guri* mix	t- value
Moisture (g)	3.25± 0.02	3.41± 0.02	8.3*
Protein(g)	10.45±0.03	16.23±0.02	274.48**
Fat (g)	2.36±0.03	3.15±0.03	31.38**
Fibre (g)	0.56±0.01	0.82±0.00	27.22**
Ash(g)	0.76±0.09	1.06±0.07	27.82**
Carbohydrates (g)	84.7±0.02	77.6±0.07	159.26**
Energy (kcal)	403±0.31	404±0.51	3.1^{NS}
Lysine (mg/100g)	247.5±2.10	444.7±2.23	95.49**
Calcium (mg)	124.12±0.23	206.2±0.84	162.06**
Iron (mg)	2.55±0.02	3.14±0.02	30.52**
Zinc (mg)	0.33±0.03	0.56±0.01	12.17**

Values are Mean±SD; **Significant at 1% level of significance; *Significant at 5% level of significance; NS- Non-significant

The increase in protein in RTU could be attributed to the addition of 30 g skimmed milk powder and bengal gram flour. A study [16] reported that on supplementation of 10% skimmed milk powder, the protein content increased from 16.2 to 21.2%. Another study [17] also suggested that skimmed milk powder has a high nutritional value and is a source of high-quality animal protein (36 g/100 g) and the addition of the milk powder (5-20%) could result in considerable increases in protein energy percentages as expected, from the level of 17–21% to 20–25%. Bengal gram has been reported to have high protein i.e. 17–22% in comparison to rice flour [18].

The fat content of roasted wheat flour and bengal gram flour incorporated RTU *sandah guri* mix was more than that of control (3.15 *vs* 2.36 g). The high fat content was due to addition of legume flour having a relatively high fat as compared to cereal flours [19, 20]. The addition of groundnut could have also contributed to fat content.

Substitution with bengal gram flour and whole wheat flour in the RTU *sandah guri* mix exhibited a significantly ($p \leq 0.01$) higher value of the ash content when compared to control (1.06 *vs* 0.76 g). Addition of skimmed milk powder could also be directed to increased ash content. Supplementation of 10% skimmed milk powder has been reported to increase the ash content of the supplementary food noodles [21].The other reason for increased ash content in ERFs could be the incorporation of bengal gram flour which has high mineral matter [22-24]. The bran from whole wheat flour also increased the ash content as reported in studies [25, 26]. In contrary to proximate principles, the calculated total carbohydrate value of RTU *sandah guri* mix was lower than the control (77.6 *vs* 84.7 g). Being the calculated value, the higher levels of protein, ash, fat and fibre in the RTU *sandah guri* mix decreased the corresponding value for carbohydrates.

The lysine content of RTU *sandah guri* mix increased significantly ($p \leq 0.01$) on addition of roasted whole wheat flour, bengal gram flour and dried skimmed milk powder as compared to control which was comprised solely of rice flour (444.6 *vs* 247.5 mg). The increase in concentration of essential amino acid in RTU *sandah guri* mix could be due to addition of whole wheat flour and bengal gram flour. The bread made of wheat flour complemented with 5, 10 and 15% of chick-pea flour had reported higher lysine content [27]. The skimmed milk powder is an important source of essential amino acids such as lysine and is the possible reason for increase in lysine content of the RTU mix.

The calcium content of RTU mix when added with roasted whole wheat flour and bengal gram flour was significantly ($p \leq 0.01$) higher as compared to control (206.2 *vs* 124.12 mg). The high calcium content in ERF 10 could be due to addition of 30 % skimmed milk powder. According to a study [17] if whey protein concentrate or skimmed milk powder is added to fortified blended foods, the content of calcium, phosphorus, and zinc especially will increase because skimmed milk powder contains almost twice the amount as whey protein concentrate.

A significant ($p \leq 0.01$) increase in the iron content was observed for RTU mix as compared to the control (3.14 *vs* 2.55 mg). The zinc content also increased significantly ($p \leq 0.01$) for RTU mix as compared to control (0.56 mg *vs* 0.33 mg). The addition of bengal gram flour could be the reason for improved mineral profile in RTU mix. In a study [28], chickpea flour when complemented with wheat flour increased iron and zinc contents of the pizza.

The results of the nutrient composition indicated that protein, fat, fibre, ash, lysine, calcium, iron and zinc can be effectively enhanced by 55.3, 33.5, 46.4, 39.5, 79.63, 66.1, 23.13 and 69.7 % respectively for RTU mix (**Figure 3**).

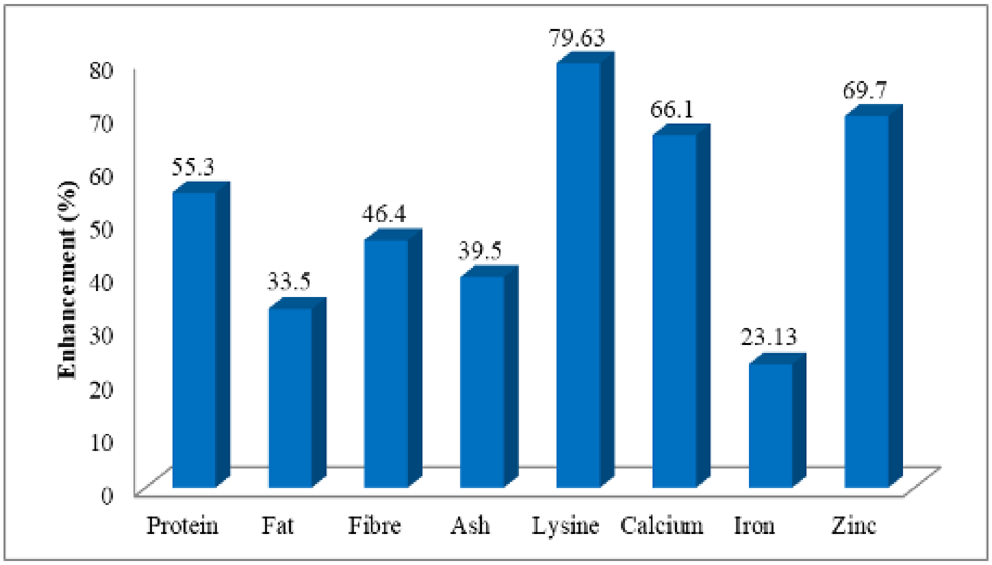

Figure 3 Enhancement (%) in protein, fat, fibre, ash, lysine, calcium, iron and zinc of RTU mix

In- vitro protein digestibility

The digestibility is an important criterion that determines the availability of physiologically active amino acids and peptides and is affected by processing treatments [29]. A significant ($p \leq 0.05$) increase in the *in vitro* protein digestibility was observed in RTU mix, in comparison to the control (87.1 *vs* 78.5 %) as depicted in **Figure 4**. The higher digestibility of RTU mix may be attributed to the possible inclusion levels of ingredients namely roasted whole wheat flour and bengal gram flour with high protein content. Roasting resulted in a slight increase in the protein digestibility value [30] because it not only remove or reduce anti-nutrients, but may also breakdown the native protein structure, including enzyme inhibitors and lectins [31] thus, increasing the digestibility.

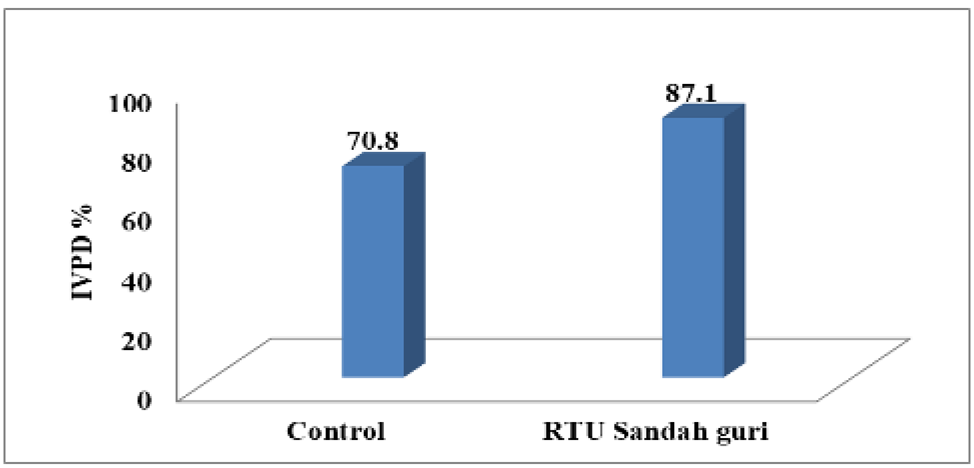

Figure 4 *In vitro* protein digestibility of RTU sandah guri mix

Net Dietary Protein Calories Percent (NDP cal %)

The ideal NDP Cal to support growth is 8%. The results show that RTU *sandah guri* mix had an NDP Cal % of 10.47 % which represents high protein quality of this RTU mix. This could be attributed to the inclusion of roasted Bengal gram flour and skimmed milk powder. Similar observations were reported in a study [17] which stated that the protein quality of products increases by the incorporation of milk products particularly skimmed milk powder or whey protein concentrate.

Storage Stability

RTU *sandah guri* mix was stored in Aluminium laminate (AL) and high-density polyethylene (HDPE) under ambient temperature (30±5ºC) and continuously monitored for moisture, free fatty acids (FFA, %oleic acid), peroxide value (PV, meqO_2 kg^{-1} fat) and sensory quality in terms of overall acceptability (OAA) during 60 days of storage.

RTU *sandah guri* mix packed in high density polypropylene showed a higher rate of moisture gain from 3.41 to 3.81% than those packed in Aluminium laminate pouches which had an increased rate from 3.41 to 3.78% (**Figure 5**). Similar results were reported in a study where the moisture content of soup mix increased from 8.95 to 8.99% and 8.95 to 9.38% for aluminum laminate pouches and LDPE respectively.

The initial value for FFA in RTU mix was 0.17 which was increased to 0.29% when stored in Aluminium pouches and to 0.34 % when packed in HDPE (**Figure 6**). Similar results were obtained in the study [16] which reported FFA content in panjiri increased from 0.161 to 0.201 during storage of 90 days. However, there was no compromise in the quality of the product.

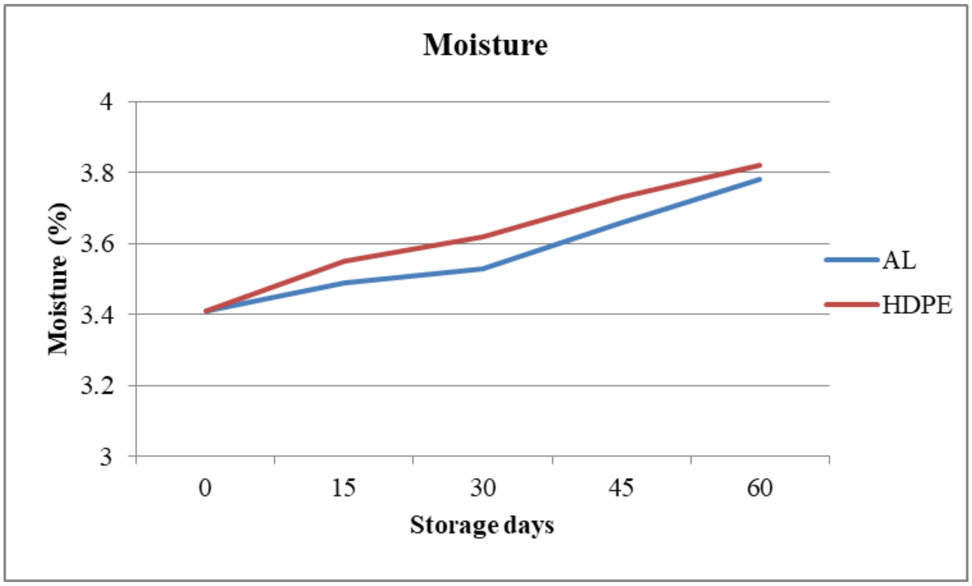

Figure 5 Moisture content of RTU *sandah guri* mix

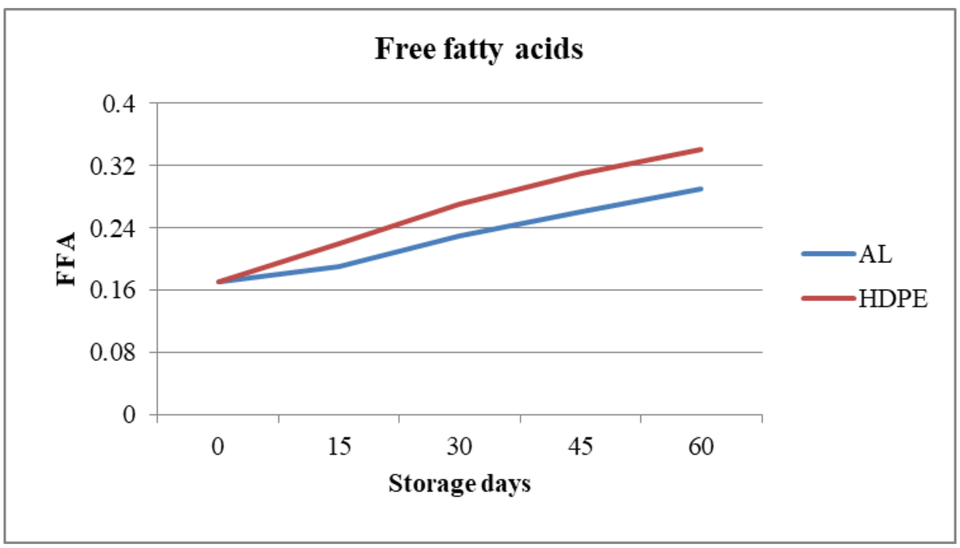

Figure 6 Free fatty acids content of RTU *sandah guri* mix

The peroxide value which is measured as rate of auto-oxidation was significantly ($p \leq 0.05$) increased during storage (60 days) and ranged from 1.34 to 4.63 % when packed in Aluminium pouches and to 5.11 % when packed in HDPE (**Figure 7**). The increase in peroxide value is due to the lipid oxidation in the presence of light and oxygen [32]. The increase in the peroxide value occurs due to oxidation of lipids as the time goes ahead. The similar trend of increase in peroxide value has also been reported for potato stuffed parathas [33]; for frozen carrot desserts [34] and for upma dry mix [35]. But this increased trend was not high enough to deteriorate the product and it was well acceptable till 60th day.

Sensory evaluation of RTU mix was carried out using a nine-point hedonic scale with nine taken as excellent in all respects while overall acceptability score below seven was taken as the unacceptable limit for the rejection of sample. The initial overall acceptability score of RTU mix was 7.96 and it dropped down to 7.45 when packed in Aluminium laminate pouches and to 7.25 when packed in HDPE during storage (**Figure 8**).

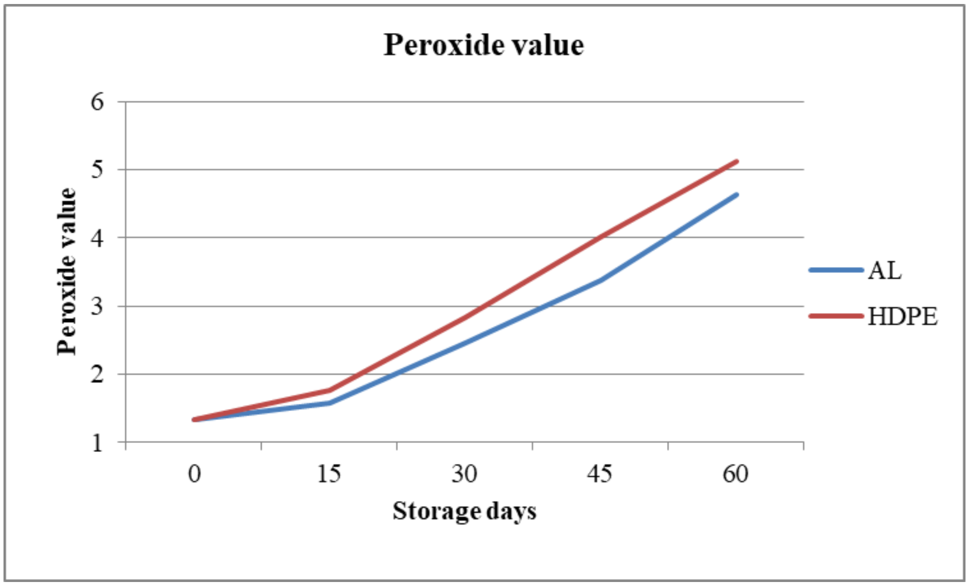

Figure 7 Peroxide value of RTU sandah guri mix

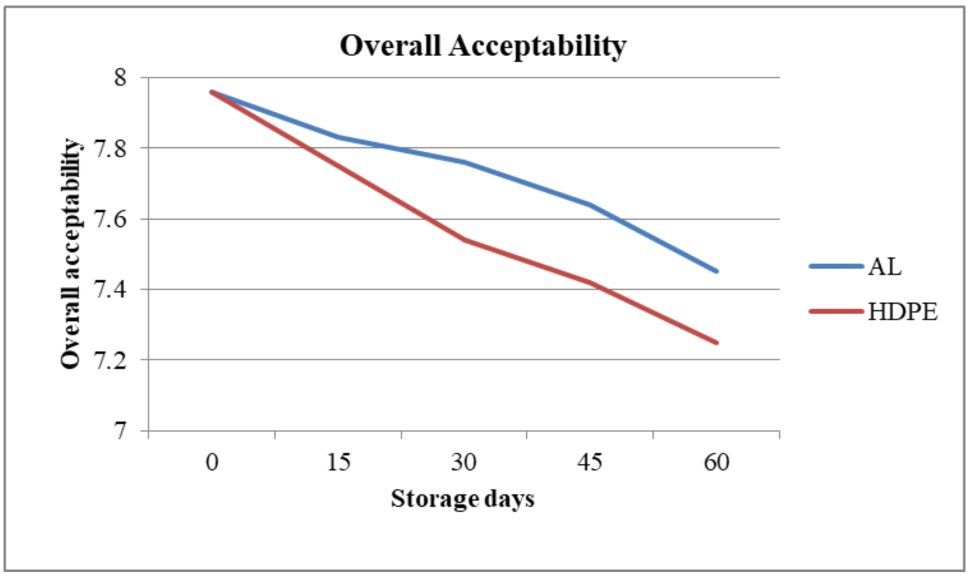

Figure 8 Overall Acceptability of RTU *sandah guri* mix

This trend of decrease in overall acceptability scores with increase in storage period is reported in several studies and may be attributed to moisture absorption, increase in peroxide value and free fatty acids which might have affected the sensory attributes of RTU mix. In a study[36] it was reported that ready to eat appetizer based on *Trachyspermum ammi* had initial values of sensory score as 8.6 which dropped down to 7.2 over the storage period. In case of an instant sweet mix based on soybean and semolina, a gradual decrease in sensory attributes had been reported in a study [37] over the storage period of six months in polypropylene pouches in ambient conditions.

The results from the present study concluded that Aluminium laminate pouches as packaging material provided better acceptability of RTU mix. Therefore, it can be stated that although both the packaging materials could be considered safer for storage of RTU mix but laminate pouches provides a better option.

Conclusion

The study revealed that emergency needs during disaster demands for ready to eat type of foods which require less time and effort to prepare them and RTU *sandah guri* mix serve this purpose best. Also it addresses the cultural competence aspect of food assistance as the traditional food can be easily relatable by the stranded population. RTU *sandah guri* mix is a nutrient dense product with high protein, calcium, iron, lysine and *in vitro* digestibility and can be stored in laminate pouches for 60 days without any compromise in its overall acceptability. Thus it can become a potential carrier of quality protein to address the needs of disaster stranded evacuees who may sustain any injury or illness and experience psychological stress leading to increased protein and energy needs.

This ready-to-use *sandah guri* mix can also be put into the food baskets of defense personnel deployed in high altitude where the demand of ready to eat foods is high as well as in the food baskets of school children who are beneficiaries under the different feeding programs running by the state.

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