RESEARCH PAPER — FOOD SCIENCE RESEARCH JOURNAL
■ Visit us : *www.researchjournal.co.in*
Volume 9 | Issue 2 | October, 2018 | 304-310
DOI : 10.15740/HAS/FSRJ/9.2/304-310

Formulation of ready-to-cook (RTC) malted little millet based complementary health food

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Standardization of process for to formulate little millet based complementary food was undertaken. The formulations were prepared by replacing malted wheat flour with malted little millet flour at 0, 25, 50, 75 and 100 per cent of. The optimized formulation was added with Skim Milk Powder (SMP) replacing green gram at 0, 25, 50, 75 and 100 per cent. The best formulation with SMP was replaced by adding Whey Protein Hydrolysate (WPH) at 50, 75 and 100 per cent. The porridge was prepared from formulations with the ratio of 1:4 (Formulation: water), cooked, cooled and served to a team of judges to adjudge the best combination. The blend with ratio of 0:100 adjudged best among the blends. The SMP (100 per cent) addition enhanced the overall acceptability of product to a significant level (8.02) compared to product with green gram flour (6.59). The product with WPH was comparable to the SMP added product. The formulated product can be conveniently stored for 60 days. It was concluded that malted little millet flour could be successfully incorporated into the little millet malt based complementary foods.

Key Words : Complementary foods, Little millet, Malting, SMP, Whey proteins

How to cite this article : Suresha, K.B., Jayaprakasha, H.M. and Ramya, K.G. (2018). Formulation of ready-to-cook (RTC) malted little millet based complementary health food. *Food Sci. Res. J.*, **9**(2): 304-310, **DOI : 10.15740/HAS/FSRJ/9.2/304-310**.

INTRODUCTION

Complementary foods are foods other than breast milk or infant formula (liquids, semisolids, and solids) introduced to an infant to provide nutrients. The ideal time to introduce complementary foods in the diets of infants is difficult to pinpoint. However, these are very important foods for the growth of the children and toddlers in addition to the breast feeding upto the age of two years. A number of successful strategies have been developed to improve complementary feeding practices in low and middle-income countries. But there is an urgent need for developing a suitable complementary food for the 2-5year age group, which is the neglected group as no complementary food is available commercially. Little millet is one of the minor millet. The crop is well known in Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Jharkhand, Madhya Pradesh, Orissa, and Gujarat and grown quite extensively in many parts of the country. The crop is strongly associated with tribal agriculture and grown as an important catch crop in view of its earliness and resistance to adverse agro climatic conditions. The formulation of complementary food to meet the requirements of the nutrients of the toddlers involves utilization of ingredients from different sources. The nutritional value of grains and seeds could be improved greatly by germination (Huang, 2006). Fermentation of the composite flour resulted in an improvement in the

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protein content (Oumarou *et al.,* 2005). There are many studies on the processing and nutritional aspects of little millet, foxtail millet and proso millet and also has developed several value-added nutri-rich products including ready-to-eat and ready-to-cook extruded products, ready to eat bakery products, Nutrimixes and Hurihittu by earlier workers (Chandru *et al.,* 2010; Ranganna, 2011 and Devi, 2012). Composite mixes were developed using little millet, cereals, pulses oilseed and green leafy vegetables by employing roasting and dehydration techniques. It was concluded that little millet can be utilized in the form of composite mix (Kurrahatti, 2010). The study on utilization of little millet was used in biscuits, vermicelli, pasta products, *Pakoda, Dosa,* masala roti, laddoo, chikki, kodubale and masala vada revealed that little millet can be incorporated from 30 to 100 per cent in the value added products (Usha, 2007). Keeping in view of above need in mind, an investigation was undertaken to standardize the process for formulating little based complementary food formulations, the process of manufacturing them for commercial exploitation and the storage stability of the developed product.

METHODOLOGY

The ingredients used in the investigation include little millet, wheat, green gram, sugar, multi-vitamins; commercially available "NANDINI" brand of skim milk powder manufactured by Mother Dairy, Yelahanka of Karnataka Milk Federation (KMF), Bangalore, Karnataka was used for formulations of millet based complementary health foods. Whey Protein Hydrolysate (WPH) of ARLA brand was procured from Sri Durga Sales corporation, Bangalore, India was used for formulations of millet based complementary health foods with WPH. Metallized Polyester (MPE) pouches were procured from Local market.

The ingredients used in the formulation of little millet malt based food were pre-processed by following standard protocol before used in the formulation. Little millet malt flour was prepared as per the procedure described by Swamy (2003) with slight modification. The whole malted wheat flour was prepared as per the procedure of Taragopal *et al.*(1982) and the green gram and other grain malt were prepared as per the procedure outlined by Malleshi (1995) with slight modifications. The parameters were optimized for the preparation of sprouted millet flours using little millet. The grains were soaked for 24 hours with a grain to water ratio of 1:3. The soaked grains were spread on a muslin cloth at a controlled temperature of 37°C. The optimum time for germination of little millet was observed to be 24-30h. The sprouted grains were dried at 50°C for 24h in a tray dryer. The dried grains were subjected to kilning in the machine to get uniform kilned grains. The resultant grains were de-husked to obtain millet rice. Milling of the millet grains was done in a domestic flour mill to get the flour.

The little millet malt based food was formulated by using malted little millet flour, malted wheat flour, malted green gram flour, SMP, Whey Protein Hydrolyzate, sugar, multivitamins and minerals. The final formulations for preparation of little millet based complementary dairy food was done with 70 % of the above blends + 11.5 % germinated and roasted green gram flour + 18.5 % sugar. The blends were added with the fixed level of sprouted green gram flour and sugar as mentioned above to prepare the final formulation of the complementary food. The flours blended with sprouted wheat flour for preparation of complementary dairy food was used as a control. The prepared formulation was made into porridge by adding the required quantity of water and cooking. The porridge samples were subjected to sensory evaluation studies to adjudge the best combination of the blend using 9 point hedonic scale by a team of judges.

Optimization of little millet malt based food:

To prepare little millet malt based complementary food, the portion of malted wheat was replaced with little millet malt at 0, 25, 50, 75 and 100 per cent levels. The blends were subjected to sensory evaluation studies after cooking to make into porridge in order to select the right levels of millet malt that could be incorporated in the foxtail millet malt based food.

The optimized little millet malt based complementary food with respect to malted little millet was further added with SMP replacing green gram. The pulses used in the study were replaced with 0, 25, 50, 75 and 100 per cent levels. The blends were reconstituted and cooked and made into porridge. The resultant gruels were subjected to sensory evaluation attribute studies in order to select the right level of replacement of malted green gram with SMP.

The best adjudged formulation with SMP was added with whey protein hydrolysate (WPH) at various levels (50, 75 and 100 % levels) to increase the protein content

of the little millet malt based complementary food. The blends were reconstituted, cooked and made into porridge. The resultant gruels were subjected to sensory evaluation attribute studies in order to select the right level of replacement of malted cereal with whey proteins.

The blends were also subjected to their physico-chemical and microbiological quality evaluation. Moisture, protein, fat, crude fibre and total ash content were determined using AOAC (1980) method. Carbohydrate content was expressed as per cent and calculated by differential method as per AOAC (1980). Gross energy was estimated as per AOAC (1980) method. Microbiological analysis with respect to total bacterial count was done as per IS: 1165-1975, coliforms was done as per IS: 5401:1969 and yeast and moulds was done as per IS: 5401-1969.

OBSERVATIONS AND ASSESSMENT

Malted flours of foxtail millet, green gram and were used for the preparation of complementary food. The chemical composition of malted flours is depicted in Table 1.

The moisture, fat, protein, carbohydrate, crude fibre, and ash content of the malted wheat flour was observed to be 5.30, 1.90, 11.35, 78.10, 1.25 and 2.10 per cent, respectively with the energy of 374.90kcal/100g. The respective compositional values in malted green gram flour for moisture, fat, protein, carbohydrate, crude fibre, and ash content were 5.75, 1.21, 24.00, 63.14, 2.30 and 3.60. The composition of the malted wheat flour and malted green gram flour were comparable with the reports of the earlier workers (Gokavi, 2001; Swamy, 2003 and Rani, 2006). Malted little millet flour had 6.35, 5.10, 11.45, 67.60, 7.60 and 1.90 per cent of moisture, fat, protein, carbohydrate, crude fibre and ash content, respectively with the energy density of 362.10 kcal/100g. The composition of malted little millet flour was in accordance with the results of Chandru *et al.* (2010) and Ranganna (2011). SMP used for the preparation of complementary food in the present investigation had the moisture, fat, protein, carbohydrate, crude fibre and ash content of 4.1, 0.0, 36.2, 54.5, 0 and 5.20 per cent, respectively, with the energy density of 362.80kcal/100g confirming to the present FSSAI standards. The respective compositional values in WPH for moisture, fat, protein, carbohydrate, crude fibre and ash content were 5.3, 6.8, 79.0, 6.60, 0.0 and 2.30 per cent with the energy density of the 403.60 kcal/100g and the values were confirming to the certificate of analysis provided by the ingredient supplier company.

Formulation of little millet based complementary health food :

Effect of replacement of malted wheat flour with malted little millet flour on sensory attributes of little millet based complementary food:

The malted wheat flour used in the standard formulation was replaced with malted little millet flour at 25,50,75 and100 per cent levels. The effect of replacement of malted wheat flour with malted little millet flour on sensory acceptability of little millet based complementary food is depicted in Table 2. Increase in the level of malted little millet flour from 0 to 100 per cent increased scores pertaining to colour and appearance. The scores for complementary food with malted wheat were 7.48 increased steadily to7.49, 7.58, 7.74 and 7.94, respectively, upon incorporating 25, 50, 75 and 100 per cent level of little millet flour. There was significant difference between the 100 per cent little millet flour blend in terms of colour and appearance with that of the control. With increase in the level of malted little millet flour in the product significantly increased the flavour attribute scores. The flavour score was 7.2 for the control was increased to 7.21, 7.35, 7.41 and 7.56, respectively, at 25, 50, 75 and 100 per cent level of malted little millet flour incorporation into the complementary food.

Table 1: Chemical composition of important food ingredients used in formulation of the complementary food

Ingredient name	Moisture (%)	Fat (%)	Protein (%)	CHO (%)	Crude fibre (%)	Minerals (%)	Energy (kcal/100g)
Malted wheat flour	5.30	1.90	11.35	78.10	1.25	2.10	374.90
Malted green gram flour	5.75	1.21	24.00	63.14	2.30	3.60	359.45
Malted little millet flour	6.35	5.10	11.45	67.60	7.60	1.90	362.10
Skim milk powder	4.10	0.00	36.20	54.50	0.00	5.20	362.80
Whey protein hydrolyzate	5.30	6.80	79.00	6.60	0.00	2.30	403.60

All values are average of three trials

The body and texture scores of the complementary food showed decreasing trend initially to 7.26 from 7.40 upon 25 per cent replacement of wheat with little millet malted flour however, the extent of decrease was insignificant. Upon increase in the flour blend further to 50, 75 per cent and 100 per cent level, the body and texture showed increasing trend with the respective scores of 7.31, 7.48 and 7.69 reflecting the improvement in the consistency of the porridge with the incorporation of malted little millet flour in the product. The scores awarded to overall acceptability attribute were 7.21, 7.28, 7.30, 7.54 and 7.61, respectively, for 0, 25, 50, 75 and 100 per cent malted little millet flour in the product. The improvement in the overall acceptability was significant (0.354) upon complete replacement of the wheat flour with little millet flour in the complementary food.

Effect of replacing malted green gram by adding SMP on sensory attributes of little millet based complementary health food:

The complementary food was formulated by adding SMP in place of malted green gram flour at 25, 50, 75 and 100 per cent keeping malted green gram blended complementary food as control. The effects of replacement of green gram protein with SMP on sensory characteristics were evaluated. The results are presented in Table 3. As the incorporation level of SMP in the complementary food increased, there was a consistent increase in the scores with respect all the sensory characteristics of the resultant product.

Colour and appearance of SMP incorporated little millet malt based complementary food increased from 6.55 in green gram based complementary food to 7.25, 7.42, 7.60 and 8.13, respectively, upon incorporation of 25, 50, 75 and 100 per cent SMP in place of green gram. The flavour scores awarded were 6.42, 6.74, 6.86, 7.12 and 7.94, respectively, for 0, 25, 50, 75 and 100 per cent SMP containing little millet malt based complementary food showing significant increase in the flavour scores at all the levels of incorporation (C.D.=0.213). The body and texture scores were also significantly increased (0.414) upon addition of SMP and the scores awarded were 6.53, 6.85, 7.14, 7.17 and 7.88, respectively, for 0, 25, 50, 75 and 100 per cent SMP containing little millet malt based complementary food. As the SMP level in the complementary food increased, sensory scores of overall acceptability attribute were also significantly increased. The overall acceptability scores were 6.59, 7.08, 7.21, 7.37 and 8.02 for 0, 25, 50, 75 and 100 per cent level of SMP incorporation in the little millet based complementary food containing SMP. Milk proteins are superior quality proteins. They possess good functional properties

Table 2: Effect of replacing malted wheat flour with malted little millet flour on sensory attributes of little millet based complementary food

Malted wheat flour : Malted little millet flour ratio	Sensory scores on 9 point hedonic scale			
	Colour and appearance	Flavour	Body and texture	Overall acceptability
100:0	7.48	7.20	7.40	7.21
75:25	7.49	7.21	7.26	7.28
50:50	7.58	7.35	7.31	7.30
25:75	7.74	7.41	7.48	7.54
0:100	7.94	7.56	7.69	7.61
C.D. (P=0.05)	0.338	0.253	0.146	0.354

All values are average of three trials

Table 3 : Effect of replacing malted green gram flour with SMP on sensory attributes of little millet based complementary health food

Malted green gram flour : SMP ratio	Sensory scores on 9 point hedonic scale			
	Colour and appearance	Flavour	Body and texture	Overall acceptability
100:0	6.55	6.42	6.53	6.59
75:25	7.25	6.74	6.85	7.08
50:50	7.42	6.86	7.14	7.21
25:75	7.60	7.12	7.17	7.37
0:100	8.13	7.94	7.88	8.02
C.D. (P=0.05)	0.438	0.213	0.236	0.414

All values are average of three trials

primarily because of their unique amino acids composition as; they provide essential amino acids required for infant and adult nutrition and also due to desirable physico-chemical attribute (Harwalku, 1993). Milk powders are extremely useful products and as this realization grows, so does the demand for a high quality product. Consumers can benefit from the durability, convenience and stability to microbial spoilage of these products (Schwambach and Peterson, 2006). In the present investigation, the SMP incorporation increased the sensory acceptability of the resultant product and the results of the study inferred that best product could be obtained by incorporating SMP completely in place of green gram.

Effect of replacement of SMP with WPH *on sensory attributes of little millet based complementary health food*:

The effect of replacement of SMP with WPH on sensory attributes of complementary food is presented in Table 4. Increase in the level of WPH in the blend slight decrease in the colour and appearance scores was observed. The scores awarded for colour and appearance were 8.00, 7.85, 7.79 and 7.82 for 0, 50, 75 and 100 per cent WPH containing product. However, the extent of reduction was insignificant suggesting no difference among the different blends. It is observed that increase in the level of substitution did not have the significant influence on the flavour of the resultant product. The flavour score for the control sample was 7.85 whereas it was 7.65, 7.81 and 7.81, respectively, for 50, 75 and 100 per cent level of substitution SMP incorporating WPH. It was evident from the result that, body and texture did not significantly wary upon substitution of SMP with WPH. The respective scores at 0, 50, 75 and 100 per cent level of substitution were 7.95, 7.70, 7.65 and 7.85.

The scores awarded for overall acceptability attributes followed similar pattern as that of other sensory attributes. Complete replacement of SMP with WPH had no effect on the overall acceptability attribute in comparison with control. The awarded overall acceptability scores at 0, 50, 75 and 100 per cent level of WPH were 8.0, 7.72, 7.78 and 7.85, respectively. Whey solids could be effectively used and should be exploited in novel food formulations to overcome the nutritional deficiencies in grains and legumes. Because of their high quality proteins, particularly the sulphur containing amino acids and acts as a balancing ingredient in weaning food formulation (Makhal *et al.,* 2003). Whey proteins contain certain inherent bioactivity which can be further nurtured and enhanced by enzymatic hydrolysis (Jayaprakasha *et*

Table 4: Effect of replacing SMP with WPH on sensory attributes of little millet based complementary health food

SMP: WPH ratio	Sensory scores on 9 point hedonic scale			
	Colour and appearance	Flavour	Body and texture	Overall acceptability
100:0	8.00	7.85	7.95	8.00
50:50	7.85	7.65	7.70	7.72
25:75	7.79	7.81	7.65	7.78
0:100	7.82	7.83	7.85	7.88
C.D. (P=0.05)	0.331	0.453	0.431	0.354

All values are average of three trials

Table 5: Overall acceptability and microbial quality of ready-to-cook (RTC) little millet based complementary health food during storage at 30±1°C

Type of complementary food	No. of days of storage				
	0	15	30	45	60
	Overall acceptability scores				
Little millet based complementary food	8.02	7.61	7.24	6.91	6.24
Microbial quality					
	No. of days of storage				
Type of complementary food	0	15	30	45	60
	Total count in log cfu/g				
Little millet based complementary food	3.96	4.24	4.58	4.69	4.92

al., 2005). From the study, it was opined that SMP could be completely replaced with WPH to have the benefit of the protein enhancement. The results reveal that the whey protein hydrolyzate could be an important ingredient in formulation of complementary foods with health benefits. In the present investigation, SMP could be completely replaced with WPH to have the benefit of the protein enhancement in the little millet based complementary food.

Storage stability of ready-to-cook (RTC) little millet based complementary food:

The best adjudged RTC malted little millet based complementary health food with SMP were packed into the MPE pouches and stored at 30±1°C. The overall acceptability and microbial quality of ready-to-cook (RTC) millet based complementary health food during storage at 30±1°C are depicted in Table 5.

The overall acceptability scores were 8.05 initially were decreased to 6.24 after 60 days of storage period for malted little millet based complementary food. The results were in agreement with the results of Ranganna (2011) and Chandru *et al.* (2010) for millet malted nutria mixes. The microbial load at the 0th day was 3.96 log cfu/g was increased as the storage period increased to 4.92 log cfu/g after 60days of storage period. The RTC malted little millet based complementary food was acceptable upto 60 days.

Conclusion:

The formulated millet based complementary food revealed that 100 per cent replacement of wheat flour with little millet flour was found to be best compared to the other blends without affecting the acceptability of the product. The formulated millet based complementary food with SMP revealed that complete replacement of green gram flour with SMP resulted in the best product compared to the other blends. Acceptability was almost same upon addition of WMP revealing complete replacement of SMP could be done with WPH to harness the benefit of the whey proteins in the resultant product. The formulated blends could be stored for 60 days at room temperature. It was concluded that the malted little millet could be one of the promising ingredient to be added into various complementary foods.

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Received : *03.03.2018;* **Revised:** *30.07.2018;* **Accepted :** *01.09.2018*