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MALTED FOXTAIL MILLET (*Setaria italica*) AND WHEAT FLOURS IN FORMULATION OF COMPLEMENTARY FOOD

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Abstract: An attempt was made to develop a complementary food using malted foxtail millet with malted wheat flours, skimmed milk powder, ghee and whey protein concentrate. The complementary food was optimized for different levels of malted wheat and foxtail millet flours, whey protein concentrate and sugar. Optimization of the complementary food was done by varying the levels of malted foxtail millet flour and wheat flours in the ratio of 10:60, 20:50, 30:40 and 35:35, whey protein concentrate at 1, 2 and 3% levels and sugar at 10, 12 and 14%. Optimization of the complementary food was done by varying the levels of malted foxtail millet flour and wheat flours in the ratio of 10:60, 20:50, 30:40 and 35:35, whey protein concentrate at 1, 2 and 3% levels and sugar at 10, 12 and 14%. To the optimized complementary food, skimmed milk powder and milk fat were added at 30 and 7% levels respectively, to meet the legal standards as prescribed by FSSAI. In order to optimize the best complementary food was subjected to sensory evaluation by a panel of judges evaluation and chemical in comparison with commercial complementary food. The complementary food showed maximum overall acceptability at 30:40 malted foxtail millet and wheat flours, WPC at 2% and sugar at 12% and also met the legal standards. The present study reveals the possibility of utilization of malted foxtail millet flour in the complementary food for better nutritional and cost effectiveness at household and industry levels.
Keywords: Complementary food, Foxtail millet, Whey protein concentrate.

INTRODUCTION

Milk is a complex fluid containing essential nutrients required for better growth of the young ones. Breast milk is the ideal food for infants up to 6 months of age. After 6 months, breast milk will not be sufficient to meet the essential nutrient requirements. Protein energy malnutrition occurs at this age. Thus, nutritious complementary foods should be given from six to twenty-four months of age (Onofiok and Nnanyelugo, 2005). Complementary foods are traditionally composed of cereals and pulses with milk powder as the main ingredients. Wheat has been extensively used, whereas utilization of foxtail millet (*Setaria italica*) is limited to rural adult and elderley population. Foxtail millet is one of the most important

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crops of semi arid tropics and it serves as a rich source of protein and minerals (Kamara *et al*., 2009). Cereal proteins are limited in essential amino acids especially lysine to overcome this, the complementary foods are enriched with milk solids in the form of skim milk powder and whey protein concentrate. Whey protein concentrate being a rich source of essential amino acids and whey proteins complement the cereal and millet proteins. Whey proteins have better nutritional value in terms of biological value, Protein efficiency ratio and Feed efficiency ratio Walzem *et al.,* (2002). Malting of cereals improves the bioavailability of nutrients. Developing millet based complementary food will come at a reasonable and affordable price for the economically weaker population of India. keeping this in view, the complementary food was formulated to meet the standards of Milk-cereal based complementary food, FSSAI (2006), with malted foxtail millet flour and wheat flour with ghee as a source of milk fat, skim milk powder, whey protein concentrate and sugar. The formulated product was subjected to nutritional and sensory evaluation.

MATERIALS AND METHODS

The raw materials for the complementary food viz., foxtail millet, wheat, sugar and Nandini brand ghee and skim milk powder (Nandini) were obtained from local market (Bengaluru) and whey protein concentrate (80%) was obtained from Mahaan Protein Limited suppliers (Delhi).

Preparation of malted flours: The malted wheat (*Triticum aestivum*) flour was prepared as per the procedure of Taragopaldas *et al.,* (1982). Cleaned wheat was subjected for germination at room temperature covered with wet cloth for 24h and was sundried till the grains become crisp. The dried wheat grains were roasted for 15min and grinded using mixer to obtain malted wheat flour. Thus obtained flour was sieved using 60mm mesh sieve.

The Foxtail millet malt was prepared as per the procedure outlined by Malleshi and Desikachar, (1985) with slight modification. The millet seeds were steeped for 24h and were allowed to germinate at room temperature for 36h. The germinated millet seeds were sundried till the grains become completely dry. The sprouted dried seeds were roasted for 15min and subjected to dehusking by using millet dehusking machine. Then the dehusked dried grains were milled to make into fine flour using electric mixer and passed through 60mm mesh sieve.

Optimization of the Complementary food: The complementary food was prepared using malted flours of foxtail millet and wheat, skim milk powder, ghee, sugar and WPC. The complementary food was optimized with respect to milk cereal based complementary food as

per the specifications of FSSAI (2006). Different proportions of malted wheat and foxtail millet flours were taken which accounted for 70 parts to which 30 parts of skimmed milk powder was added. To this, ghee was added at the rate of 7 per cent. In order to optimize the levels of malted foxtail millet flour, millet flour and wheat flour were taken at the following proportions 30:40, 35:35, 20:50 and 10:60. The complementary food, which was optimized with respect to malted foxtail millet flour, was added with different levels of WPC at 0, 1, 2 and 3 per cent. Thus, optimized complementary food enriched with WPC was added with 10, 12 and 14 per cent levels of sugar in order to enhance the taste.

Sensory evaluation: The dry blends of complementary food CF_1, CF_2 and control were reconstituted with 25 per cent total solids, cooked into gruel and subjected to sensory and nutritional evaluation. The sensory evaluation of the complementary food was carried out by reconstituting and cooking it into gruel at 75ºC/10min and was served to a panel of 5 judges and judged by 9-ponit hedonic scale.

Statistical analysis: The data obtained in the research work was analyzed using One way ANOVA using R software (R. version 3.1.3(2015-03-09). Copyright (C) 2015. The R foundation for statistical computing to calculate mean and critical difference to prove significant or non-significant effect of the parameters adopted in the present study.

RESULTS AND DISCUSSION

The milk cereal based complementary food was prepared by adding 30parts of skim milk powder, 70 parts of cereal and millet flours and 7 parts of ghee. The above mentioned quantity of skim milk powder and ghee were incorporated in order to meet the legal standards as prescribed by FSSAI (2006). That is the Milk- cereal based complementary food must contain minimum 10 per cent milk protein and 5 per cent milk fat.

Effect of various levels of foxtail millet flour and wheat flour on the sensory attributes of the complementary food

To optimize the levels of cereal and millet flours, different proportions of malted foxtail millet flour and wheat flour were blended at the following proportions 10:60, 20:50, 30:40 and 35:35, considering the commercial sample as control complementary food. The effect of addition of foxtail millet flour at different levels on the sensory evaluation of the complementary food is presented in the table I

It is evident from the table I that, there was no statistical significant difference ($P \leq 0.05$) in colour and appearance scores of the control and experimental complementary foods. This indicated that the blending of foxtail millet malt and wheat malt at different levels did not

influence any change in colour and appearance of the complementary food. This could be attributed to the similar colour and appearance of the foxtail millet malt and wheat malt.

The maximum flavor score were awarded to the samples 30:40 and 35:35 blends. With increase in the rate of incorporation of malted foxtail millet flour from 10:60 to 30:40, there was an increase in the flavor scores. As observed, the malted foxtail millet flour produced characteristic malted flavor when compared to the wheat flour. Similar trend was observed by Balasubramanian *et al.,* (2014) in the weaning food prepared using different levels of malted pearl millet and barley. The flavor of the complementary food increased for those formulas prepared using a higher concentration of malted millet flour. The increase in flavor scores in the experimental samples is attributed to the fact that during germination there will be increase in the free sugars increasing the sweetness perception due to increased α- amylase activity and there would be development of characteristic flavor which play a role in the flavor profile of malted complementary food (Sarker, 2015).

The consistency scores of complementary food improved with an increase in rate of addition of malted foxtail millet flour. The maximum score was awarded to the sample with 30:40 (Foxtail millet malt: Wheat malt). The decrease in consistency score above 30:40 blends is because of the increased levels of foxtail millet malt, which resulted in decreased levels of wheat malt, with decrease in the levels of wheat malt there was formation of thick and pasty gruel.

The maximum overall acceptability score of 7.83 was awarded to the sample with 30:40 (Foxtail millet malt: Wheat malt), which had comparatively higher scores for colour and appearance, flavor and consistency than the other experimental complementary foods. The control sample showed maximum score for all the sensory attributes.

Effect of various levels of whey protein concentrate on the sensory attributes of the complementary food

The optimized complementary food with 30 parts of skim milk powder, 30 parts of malted foxtail millet flour, 40 parts of malted wheat flour and 7 parts of ghee was incorporated with different levels of whey protein concentrate. The effect of enrichment of complementary food with whey protein concentrate at 1, 2 and 3 per cent levels on sensory characteristics is presented in the table II.

Upon increase in the levels of addition of whey protein concentrate, there was significant difference in the sensory attributes with respect to colour and appearance, body and texture and overall acceptability. The maximum score of 8.0 was awarded to the complementary

food enriched with 2 per cent of WPC and the same score was observed with the control sample, as both complementary foods had better colour and appearance, which is attributed to the functional properties imparted by addition of WPC. Addition of WPC at 2 per cent levels formed gruel of right consistency with smooth texture in the product making it highly desirable. The decrease in sensory score for sample with 3 per cent WPC could be attributed to the formation of thick gel like porridge with large size grains. Gelation is one of the important functional properties of whey proteins (Thapa and Gupta, 1992).

The highest score of 8.16 was awarded to the sample with 2 per cent WPC, which was higher than the score of control sample 8.00. The lowest score was given to the sample with 1 and 3 per cent WPC. Based on the desirable attributes imparted by the addition of WPC to the complementary food, the optimum level of WPC incorporation was found to be 2 per cent. However, above 2 per cent level, the complementary food showed relatively lower score as a result of more jelly like pasty structure.

The maximum overall acceptability score was awarded to the complementary food incorporated with 2 per cent WPC but was lesser than the control, sample with 2 per cent WPC showed higher scores for colour and appearance, flavor and better consistency. WPC is well known to add on to the mouth feel of the complementary food when incorporated in the product (Mulvihill, 1991). Hence, the panel of judges evaluated complementary food with 2 per cent WPC for further studies.

Effect of various levels of sugar on the sensory attributes of the complementary food

The complementary food optimized with 30 parts skim milk powder, 30:40 parts foxtail millet flour and wheat flour, 7 parts ghee and 2 per cent WPC was added with 10, 12 and 14 per cent sugar and optimized with respect to sugar to get desired attributes. The effect of addition of sugar on the sensory attributes of the complementary food is presented in the table III.

The results from the table reveal that, there was no statistical significant difference ($P \leq 0.05$) with respect to colour and appearance upon addition of sugar. This concludes that, the addition of sugar does not significantly influence the colour and appearance scores of the product.

It is evident from the result that there was an improvement in the sensory score with respect to flavor as the sugar level increased. The maximum score was given to sample with 12 per cent sugar. The scores increased from 10 to 12 per cent, but decreased at the levels of 14 per cent addition. The increase in flavor is attributed to the fact that sugar is a sweetening agent

and aids in enhancing the taste of the product. However, the extent in increase in the flavor was only until 12 per cent addition, the decrease at 14 per cent level is ascribed to higher levels of sweetness.

It is clear from the table that, the maximum score was awarded to the sample with 12 per cent sugar. Addition of sugar showed improvement in consistency from 10 to 12 per cent but at 14 per cent levels of incorporation the score decreased because there was a formation of thick gruel due to increased total solids level. With respect to consistency, the experimental sample with 12 per cent sugar had higher score than the control, which is due to the right consistency attained by the product at 12 per cent addition of sugar.

The overall acceptability score was maximum for control, followed by complementary food with 12 per cent sugar. The sample with 12 per cent sugar showed optimum scores with respect to other sensory attributes like colour and appearance, flavor and consistency. Hence, the panel of judges evaluated complementary food with 12 per cent sugar as the complementary food with maximum overall acceptability scores.

Sensory attributes of the formulated complementary food

As indicated in the table IV, the score for control with respect to colour and appearance was highest. The control sample scored 8.33, the sample CF_1 scored 7.83 and sample CF_2 secured 8.08. The control complementary food was brighter in colour when compared to the experimental complementary foods. With respect to flavor, the product prepared using malted foxtail millet scored maximum compared to the control. The scores secured for flavor attribute were 8.16 for CF_1 and CF_2 as against control complementary food with 7.91, respectively. The increase in the flavour scores in the optimized complementary food may be attributed to the fact that during germination there would be an increase in the free sugars increasing the sweetness perception and there will be development of characteristic malted flavour, which play a role in the flavour profile of the malted complementary food (Sarker, 2015). Higher score for consistency was awarded to the CF_2, followed by CF_1, as against 8.16 for control, respectively. The better consistency of the complementary food with WPC may be ascribed to the functional properties imparted by WPC viz., water binding capacity (Thapa and Gupta, 1992). CF_2 scored the maximum followed by CF_1 and control for overall acceptability attribute. Statistical analysis of the results revealed that there was significant difference ($P \leq 0.05$) between the control and complementary foods with respect to all the sensory attributes.

CONCLUSION

Effective utilization of malted Foxtail millet with malted wheat, Whey protein concentrate and skim milk powder would be an effective strategy to overcome the nutritional deficiencies in infants. The formulated complementary food with 30 parts malted foxtail millet and 40 parts wheat flours enriched with WPC at 2 per cent levels and 20 per cent SMP showed better sensory scores compared to the wheat based commercial brand. Thus, it can be concluded that, a complementary food can be formulated with WPC at industrial level and without WPC at household level using foxtail millet and wheat malt blends.

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Table I: Effect of various levels of foxtail millet flour and wheat flour on the sensory attributes* of the complementary food

Foxtail millet malt: Wheat malt	**Sensory attributes (Max. score: 9.00)**			
	Colour and appearance	Flavour	Consistency	Overall acceptability
Control	8.00	8.08	8.00	8.00
10: 60	7.83	7.16	7.08	7.33
20: 50	7.75	7.41	7.33	7.50
30: 40	7.75	7.66	7.83	7.83
35: 35	7.75	7.66	7.58	7.58
CD (P ≤0.05)	NS	0.33	0.37	0.28

All values are average of three trials
*Scores graded based on 9 – point hedonic scale

Table II: Effect of various levels of whey protein concentrate on the sensory attributes* of the complementary food

Levels of WPC (%)	**Sensory attributes (Max. score: 9.00)**			
	Colour and appearance	Flavour	Consistency	Overall acceptability
Control	8.00	8.08	8.00	8.00
1.0	7.83	7.16	7.41	7.83
2.0	8.00	7.33	8.16	7.91
3.0	7.50	7.33	7.58	7.58
CD (P ≤0.05)	0.30	0.21	0.47	0.24

All values are average of three trials
*Scores graded based on 9 – point hedonic scale

Table III: Effect of various levels of sugar on the sensory attributes* of the complementary food

Sugar (%)	**Sensory attributes (Max. score: 9.00)**			
	Colour and appearance	Flavour	Consistency	Overall acceptability
Control	8.00	8.08	8.00	8.08
10	7.66	6.58	7.83	7.08
12	7.83	8.00	8.08	8.00
14	7.58	7.41	7.75	7.66
CD (P ≤0.05)	NS	0.34	0.23	0.27

All values are average of three trials
*Scores graded based on 9 – point hedonic scale

Table IV: Sensory attributes* of the formulated complementary food

CF	**Sensory attributes (Max. score: 9.00)**			
	Colour and appearance	Flavour	Consistenc y	Overall acceptability
Control	8.33	7.91	8.08	8.16
CF_1	7.83	8.16	7.75	8.00
CF_2	8.08	8.16	8.16	8.33
CD (P ≤0.05)	0.29	0.28	0.28	0.23

All values are average of three trials
*Scores graded based on 9 – point hedonic scale
CF – Complementary food
CF_1 – Foxtail millet malt: Wheat malt (30: 40) + 30 parts SMP + 7 parts ghee + 12% sugar
CF_2 – Foxtail millet malt: Wheat malt (30: 40) + 30 parts SMP + 7 parts ghee + 2% WPC+ 12% sugar