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QUALITY ATTRIBUTES OF COMPLEMENTARY FOOD PREPARED USING MALTED WHEAT AND FOXTAIL MILLET (*Setaria italica*) FLOURS WITH MILK SOLIDS

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Abstract: A study was undertaken to formulate a complementary food with malted foxtail millet flour and wheat flour with skimmed milk powder, ghee, whey protein concentrate and sugar to obtain a complementary food that meets the standards of FSSAI. The formulated complementary food was optimized for optimum level of total solids in the gruel, which was found to be best at 25 per cent total solids level. The complementary food with WPC along with a commercial sample was evaluated for proximate composition and was found to contain 17.0, 7.69, 3.04, 0.98 and 67.08 per cent of protein, fat, ash, crude fibre and carbohydrate respectively. The physical parameters bulk density and spreadability of the complementary food were found to be 0.66 and 0.56 g/ml and 24.66 and 26.13% spread for sample with WPC and control, respectively. The microbial tests carried out for the freshly formulated complementary foods showed that the total bacterial count, coliforms and yeasts and molds were well within the standard limits and were safe doe consumption.

Keywords: Complementary food, Coliform, Foxtail millet, Milk solids.

INTODUCTION

The complementary foods are very important for the growth of infants in addition to breast-feeding up to the age of two years. Infants and young children are more vulnerable to risk of malnutrition from 6 months of age onwards, where breast milk will be no longer sufficient to meet all the required nutrients, at this age nutritious complementary foods must be introduced along with the breast milk (Onofiok and Nnanyelugo, 2005). Poor quality weaning foods and improper weaning practices makes infants vulnerable to malnutrition, growth retardation, infection, diseases and high mortality (Prentice and Moore, 2005). The high proportions of complementary foods are prepared from nursing mothers by making use of locally available cereals and pulses. The nutritional compositions of these foods are of high quality and suitable for low income group of people who are unable to access commercial

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complementary foods (Ijarotimi and Ogunsemore, 2007). Wheat is the extensively used cereal, where as utilization of foxtail millet is limited to rural areas. Foxtail millet is considered as a crop for poor people, it is highly nutritious with nearly 14.0 per cent protein and 4.6 per cent fat. It is tasty, non – glutinous and easy to digest (Malleshi and Desikachar, 1985). Cereal proteins lack in essential amino acids especially lysine, to overcome this milk solids in the form of skimmed milk powder and why protein concentrate were added. Thus, keeping in the view of above said facts a study was conducted to explore the quality attributes of complementary food prepared using malted foxtail millet and wheat flours with skimmed milk powder and whey protein concentrate to meet the legal standards prescribed by FSSAI (2006). The formulated product was subjected to physical, chemical and microbial evaluation.

MATERIALS AND METHODS

The raw materials required for the formulation of complementary food namely foxtail millet, wheat and sugar, Nandini brand ghee and skimmed milk powder were purchased from the local market (Bengaluru) and whey protein concentrate (WPC 80) was procured from Mahaan Protein Pvt Ltd company suppliers, New Delhi.

Processing of raw materials

Preparation of malted flours:

The malted wheat flour and malted foxtail millet flour were prepared as per the procedure outlined by Taragopaldas *et al.,* (1982) and Malleshi and Desikackar, (1985) respectively. the grains were cleaned and subjected to germination at room temperature. Germinated grains were sundried till it became crisp and were roasted for 15min and grinded using mixer. Thus obtained malted flours were sieved using 60mm mesh sieve.

Formulation of complementary food

The complementary food was formulated using foxtail millet and wheat malt, skimmed milk powder, ghee, sugar and whey protein concentrate meeting the legal standards prescribed by FSSAI (2006) for Milk-Cereal based complementary food. The formulated complementary food contained 30 parts foxtail millet malt, 40 parts malted wheat flour, skimmed milk powder 30 parts, ghee 7 per cent, sugar at 12 per cent added without (CF_1) and with (CF_2) whey protein concentrate at 2 per cent levels respectively.

Process optimization of total solids in the gruel of the formulated complementary food

The optimized complementary food prepared with the admixture of wheat malt, foxtail millet malt along with other ingredients was reconstituted in potable water. It was cooked at

75ºC/10min to have 15, 20, 25 and 30 per cent total solids in the gruel. The resultant product was evaluated by subjecting to sensory evaluation by a panel of 5 judges. The formulated complementary food was compared with the wheat based commercial complementary food that was reconstituted at 33.33% total solids level as per the instructions given by manufacturer..

Proximate composition

The proximate composition of the optimized complementary food formulated complementary food CF_1, CF_2 and control complementary food were analyzed, the moisture, protein, fat, ash, crude fibre, carbohydrates and energy values were determined as per the procedure of AOAC (1980).

Physical properties of the complementary food

The physical properties namely titratable acidity, spreadability and bulk density of CF_1 , CF_2 and control complementary food were determined.

Titratable acidity of the complementary food was measured by titrating against standard 0.1N NaOH using phenolphthalein as indicator and expressed in terms of per cent lactic acid as per the method described in IS:SP:18 (Part XI) 1981.

Spreadability of the gruel of the formulated complemenatry food was measured by adopting the procedure as described by Prasannappa *et al.* (1972).

Bulk density was determined as per the procedure developed by Subramanian and Viswanathan (2007).

Enumeration of Standard plate count, Coliform count and Yeast and molds counts

The freshly prepared samples of complementary food CF_1, CF_2 and control complementary food were subjected for enumeration of TBC (IS-5402:1969), Coliform count (IS 5401-1969), Yeast and Molds (IS 5403-1969) count in order to declare the acceptability of the product.

About 11gms of complementary food sample was weighed to sterile aluminium foil. Then, the weighed sample was transferred to sterile mortar and then transferred into 99ml of phosphate buffer triturated with the help of pestle that constituted 1:10 dilution. The samples were serially diluted by transferring 1ml of sample to 9ml diluent to get 1:100, 1:1000 and 1:10000 dilutions respectively.

For enumeration of TBC, Coliforms and Yeat and molds approximately 10-15ml of SPCA, VRBA and MEA medium was poured into the plates, allowed for solidification and incubated keeping the plates inverted at 37ºC/24-48h, 37ºC/18 – 24h and 30ºC / 3-5 days respectively.

The plates having the colonies between 30 and 300 were selected, and counted using colony counter. The counts were expressed as cfu/g.

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

RESULTS AND DISCUSSION

Effect of various levels of complementary food upon reconstitution on the sensory attributes of complementary food

The effect of addition of different levels of total solids for cooking the gruel on various sensory attributes is presented in the table I. From the table it is observed that, there was an increase in all the sensory attributes up to 25 per cent total solids level and at 30 per cent total solids level sensory scores declined.

It is clear from the table that, the highest colour and appearance score was awarded to the control and the complementary food with 25 per cent total solids. The lesser scores were given to the samples with 15 and 20 per cent total solids. This decrease in scores is due to the formation of thin gruel, which gave watery appearance, where as the product with 30 per cent total solids formed thick gruel which resulted in pasty appearance. There was no significant difference with respect to flavor of the complementary food. The maximum sensory scores were observed in the gruel with 25 per cent total solids. The consistency score of the complementary food was maximum at 25 per cent total solids level, below that the formed gruel appeared very thin and above 25 per cent level the gruel formed was very thick and pasty. The optimum level of incorporation of total solids for the formation of gruel with a desirable consistency was only 25 per cent for the experimental sample, where as it was 33.33 per cent for the control. The higher levels of total solids incorporation in control is due to the fact that the control sample prepared only with wheat flour is known to form thinner gruel as a consequence of higher amylase activity. As a result, to form the gruel with optimum consistency, the level of addition the product is higher for the control to form the gruel with right consistency when compared to the experimental complementary food. The maximum scores overall acceptability score was given to the product with 25 per cent total solids, which had scores on par with the control, which had better scores for colour and

appearance, flavor and consistency. Thus, the product with 25 percent total solids secured higher sensory scores as it had a right consistency desired for feeding the infant.

Proximate composition of the complementary food

The moisture content of the control sample, sample, CF_1 and CF_2 was 4.98, 4.96 and 4.97 per cent, respectively (Table II). There was an increasing trend in the protein content of the complementary foods. The protein content was found to be maximum in the CF_2 viz., 17.03 per cent followed by CF_1 and control, which was found to contain 15.98, 15.07 per cent, respectively. The higher protein content in the formulated complementary food might be ascribed to higher levels of protein in foxtail millet (13.18 per cent) and WPC (80 per cent). The fat content of the formulated complementary food was lesser than the control complementary food, but it met the standard limits prescribed by FFSAI, (2006). The fat content of the control, CF_1 and CF_2 was 9.10, 7.62 and 7.69 per cent respectively. The increase in the fat content of the complementary food with WPC may be attributed to the contribution of the fat from WPC, which contains nearly 6.5 – 8 per cent fat (Tania and Xavier, 2013). There was an increase in the ash content of the optimized complementary food compared to the control. The control sample had an ash content of 1.47 per cent while that for CF_1 and CF_2 were found to contain 3.36 and 3.40 per cent of ash, respectively. The increase in ash content was mainly due to increased mineral content in the foxtail millet and WPC, which contains 3.37 and 4.00 per cent ash respectively. The crude fibre content for the control sample was 0.97 per cent, whereas it was higher in the case of CF_1, viz., 1.00 per cent and for the sample CF_2 it was 0.98 per cent. The carbohydrate content of the experimental complementary food was lesser than the control sample. The control sample had significantly higher carbohydrate content of 68.4 per cent than CF_1 and CF_2. The carbohydrate content of CF_1 and CF_2 were found to be 67.05 and 66.05 per cent respectively. The energy values of the sample CF_1 and CF_2 was 400.82 and 401.05 kcal/100g, respectively, which was lesser than the control complementary food with 415.81 kcal. The control sample showed higher energy values than the CF_1 and CF_2. Statistical analysis of the results revealed a statistical significant difference ($P \leq 0.05$) with respect to protein, fat, ash, carbohydrates and energy values between all the three complementary foods.

Physical attributes of the complementary food

The control sample, CF_1 and CF_2 subjected for determination of physical parameters like titratable acidity; bulk density and spreadability are presented in the table III.

Titratable acidity

The titratable acidity of the formulated complementary food was higher (0.31 and 0.33% lactic acid) than the control with 0.30 per cent lactic acid. Higher acidity of the optimized complementary food may be attributed to the higher bacterial count in the optimized product.

Bulk density

The bulk density of the control is 0.56g/ml, that of dry blending of experimental complementary food was 0.67 and 0.66g/ml, which indicates that the space required for storage is lesser for optimized complementary food than the control.

Spreadability

The spreadability of the control sample was higher than CF_1 and CF_2, this may be due to the fact that, the control sample manufactured only out of wheat are known to form thin and low viscous gruel when compared to millets which form thick gruel (Mondimu and Malleshi, 1996).

Microbiological quality of the complementary food

The microbiological quality of the freshly formulated complementary food (Table IV) prepared by dry blending of ingredients was subjected for analysis of microbial parameters TBC, coliforms and yeast and molds immediately after the preparation. The TBC counts were 3.21, 3.39 and 3.44 log10 cfu/g for control, complementary food without and with WPC respectively. The control and optimized complementary food showed presence of total bacterial count due the presence of viable organisms, which may be the contaminants from malted wheat or foxtail millet flour, sugar and WPC. However, the sample did not show the presence of coliforms or yeast and molds.

CONCLUSION

Foxtail millet limited only to the rural areas can be effectively utilized with wheat malt, whey protein concentrate and skimmed milk powder. This would be affordable to all the sections of the society to overcome nutritional deficiencies. The formulated complementary food had similar nutrient composition that of control and all the three complementary foods had lower microbial counts and were safe for consumption and were within the standard limits.

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Table I: Effect of various levels of complementary food upon reconstitution on the sensory attributes* of complementary food

Total solids (per cent)	**Sensory attributes (Max. score: 9.00)**			
	Colour and appearance	**Flavour**	**Consistency**	**Overall acceptability**
Control(33.33%)	8.08	8.08	8.16	8.16
15	7.41	7.83	6.83	7.33
20	7.75	8.00	7.00	7.50
25	8.08	8.08	8.33	8.16
30	7.83	8.08	7.33	7.50
CD (P ≤0.05)	0.31	NS	0.42	0.28

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

Table II: Proximate composition* of the formulated complementary food (dry blends)

Type of CF	Moisture	Protein	Fat	Ash	Crude Fibre	Carbohy drates	Energy (kcal)
Control	4.98	15.07	9.10	1.47	0.97	68.4	415.81
CF_1	4.96	15.98	7.62	3.36	1.00	67.08	400.82
CF_2	4.97	17.03	7.69	3.40	0.98	65.93	401.05
CD (P ≤0.05)	NS	0.07	0.12	0.06	NS	0.18	0.53

All values are average of three trials.
NS – Non-Significant
* Expressed as percentage
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.

Table III: Physical attributes of the formulated Complementary food

Type of CF	Titratable acidity (% LA)	Bulk Density (g/ml)	Spreadability (%)
Control	0.30	0.56	26.13
CF_1	0.31	0.67	24.13
CF_2	0.33	0.66	24.66
CD ($P \leq 0.05$)	0.0018	0.017	0.16

All values are average of three trials
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

Table IV: Microbial counts* in the freshly formulated Complementary food (dry blends)

Type of CF	TBC	Coliforms	Yeast and Molds
Control	3.21	0.00	0.00
CF_1	3.39	0.00	0.00
CF_2	3.44	0.00	0.00

All values are average of three trials
*Expressed as Log_{10} cfu per gram
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