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Formulation of weaning food with fortification of orange (*Citrus sinensis*) waste

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The study was conducted to formulate weaning food by using sorghum, green gram, rice and foxtail millet. Different proportions of orange waste (peel and pomace powder) were incorporated at different proportions. Weaning food was prepared using roasting and malting techniques. Based on the sensory evaluation, the malted sample was selected. Out of the three formulation studies, the sample T_3 was found richest in the protein (17.07 %) and fat (4.2 %) containing 30 per cent orange waste combination Powder. The mean score of different oraganoleptic characteristics of the energy food formulations showed that sample T_2 containing 20 per cent orange waste combination Powder was significantly superior over sample T_1 and T_3though the sample T_3 containing more nutritional profile, but least accepted .The pre treatments such as malting and roasting are given to the above selected weaning food (sample T_2) for improving their organoleptic characteristics and the results revealed that among all the four developed weaning foods, the malted food was organoleptically superior yielding a good quality product. The results on physical properties of developed weaning foods showed that the malted weaning food had the lowest density and water absorption capacity and high dispersability.

Key Words : Weaning food, Organoleptic, Malting, Roasting, Water absorption capacity, Dispersibility

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INTRODUCTION

Weaning is a gradual process of introducing solid foods to an infant's diet, alongside breast milk from the age of three to four months, since the breast feeding alone cannot meet the infant nutritional requirement (Salmon and Shackefford, 2008). Accordingly, formulation and development of nutritious weaning foods from local and readily available raw materials has received considerable attention in many developing countries. The commercially standardized foods are generally magnificent and can help meet the nutritional requirements of young children in both developed and developing countries (Asma *et al.*, 2006). Protein-energy malnutrition generally occurs during the crucial transitional phase when children are weaned from liquid to semi-solid or fully adult foods. During this period, children need nutritionally balanced, calorie-dense supplementary foods in addition to mother's milk because of the increasing nutritional demands of the rowing body. In most developing countries, the prevalence of under nutrition and micronutrient deficiencies is high among infants and young children aged 6 to 23 months, which increased the risk of underweight, stunt growth, and death at these ages (UNICEF, 2009). Main by-products of citrus processing are the peel, pulp and seeds, which account for 40-60 per cent of the weight of the raw material these residues can be further processed into 3 main categories: animal feed, raw material used for further

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extraction of marketable products and food products. Although most of the citrus by-products are used for animal feed there are many useful by-products made from different portions of the citrus fruits, such as pectin, dried pulp, molasses, marmalades, candied peel, peel seasoning, purees, beverage bases, citrus alcohol, bland syrup, citric acid, seed oil, flavonoids and other products. In the past, by-products became the source of additional revenue for many citrus processors with low juice values. Hence, the utilization of citrus by-products to produce more valuable products is getting increasingly important as future world citrus production increases and then surpasses the demand for citrus juices and beverage products. Furthermore, the future uses of citrus byproducts will also need to expand beyond the current major use as low-value animal feed (Licandro and Odio, 2002).

METHODOLOGY

Oranges :

Nagpur Variety of Oranges was obtained from local market of Parbhani district, Maharashtra.

Proximate analysis and sensory evaluation of prepared weaning food :

Analysis for moisture, ash content, crude protein, crude fat, crude fibre and carbohydrate were carried out according to their respective methods (AOAC, 2005). The determination of Calcium, Magnesium, Potassium, Phosphorus and Iron were done as per the method described by Ranganna (1986). All the tests were executed in triplicates. Sensory evaluation of prepared products was based on 9- point hedonic scale.

Development of orange (*Citrus sinensis*) based weaning food :

The selected food stuffs (Sorghum flour, rice flour, green gram flour and foxtail millet flour were cleaned and processed by the selected processing techniques before developing the weaning mix. For the preparation of roasted flours of selected foodstuffs, the ingredients where dry roasted for 5 to10 minutes on low flame, ground well and sieved. Malted flours of selected foodstuffs were prepared as per the method described by Malleshi and Desikachar (1982).Different steps of processing techniques are shown in Fig. A. The proportion of foodstuffs and orange waste powder and protein concentrate are also kept variable in each energy food formulation. All the formulated weaning food were evaluated by semi trained pannel members for organoleptic characteristics. The weaning food which had scored the maximum points for overall organoleptic qualities were selected for further evaluation.

Method for preparation of weaning food :

Roasted weaning food:

The raw material used for the preparation of weaning food *viz;* Sorghum, green gram, foxtail millet and rice were cleaned and sorted. Roasting was done at 70-80°C for the time of 10-12 minute in a stainless steel pan at low flame to avoid the burning of the grains. Roasting was followed by grinding in the electrical grinder to make fine flour and sieved by 60 mesh sieves. Roasting give a pleasant flavor to flour (Salve *et al*., 2011). The weaning food was prepared by modifying the method given by Amankwah *et al*. (2009) and Annan and Plahar (1995).

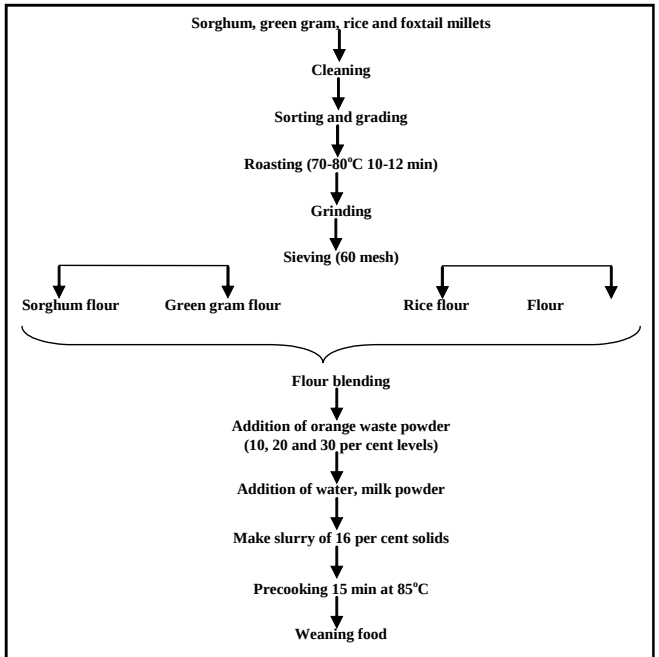
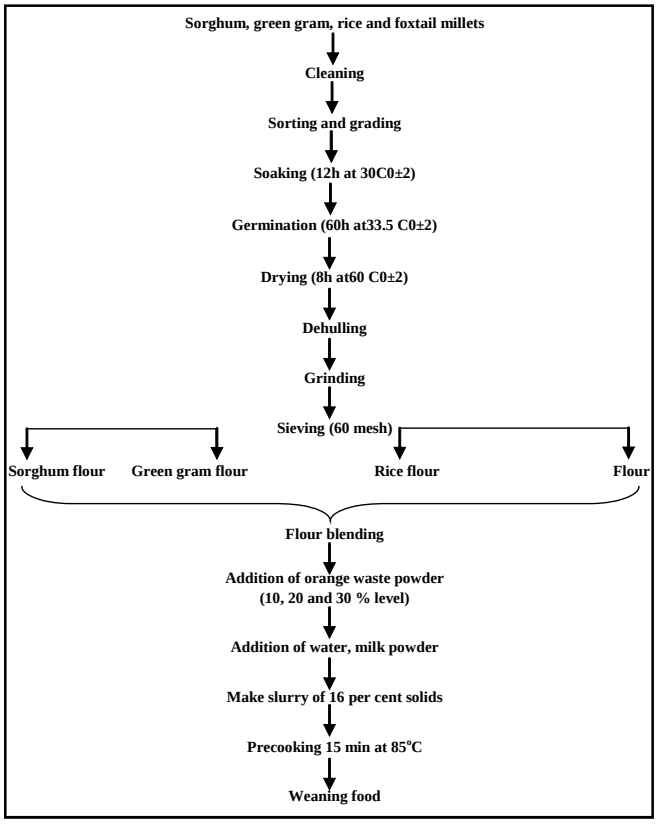


Fig. A : Flowchart for processing the raw ingredients used in the weaning foods malted weaning food

The flour samples prepared by taking 500 g of sorghum, foxtail millet, green gram and rice were sterilized by soaking in ethanol 2 per cent for 1 min. The grains then soaked in tap water for 12 h at room temperature. The soaked seeds were germinated in petri dishes with wet cotton at dark place. Two layers of wet paper towels were used to cover the seeds to prevent rapid moisture

loss. They were germinated at 33.5 ± 2°C and watered 2 to 3 times a day for 60 h. The sprouts were washed and dried at 130°C for 1 h in an electric oven. The dried sprouts were ground in a hammer mill and sieved with a 60 mesh screen. The flour was put, in triplicates, into polyethylene bags and packed in a glass container. They were stored in a refrigerator at 4°C until nutritional analysis. The weaning food is prepared according to the process given by Bisla *et al.* (2012) and Tehseen *et al.* (2014).



OBSERVATIONS AND ASSESSMENT

Table 2 revealed that the proximate composition *viz.*, moisture, protein, fat, crude fibre, ash and carbohydrates of three formulated weaning food after addition of different levels of orange waste powder. It can be seen from the table that the moisture content values are lower in the entire samples compare to control samples on evaluation of result it was found that there was decrease in moisture content in the sample with increasing the level of orange waste powder. The highest moisture content (3.58 %) found in sampleT_1. The moisture content of the product was all below 10 per cent these values are lower enough to allow for good storage if packed properly. Sample T_1, T_2 and T_3 are found to be statically at par with each other however sample T_3 had lower moisture content than sample T_1 and T_2.

Out of three formulation studies, the sample T_3 was found richest in the protein (17.07 %) and fat (4.92 %) containing 30 per cent orange waste combination powder. Protein contet of formulated weaning foods were observed in the range between 13.05 to 17.07 per cent. It was also seen from table that protein content values are gradually increased with increase of orange waste combination powder the lowest protein content (13.05 %) was found in the control sample. The protein content of sample T_2 and T_3 containing 20 and 30 per cent of respectively fulfilled the daily protein allowance as suggested by Bureau of Indian Standards (2006) for infants. It is also evident from table that the dietary fibre content are significantly increased in all the formulated samples with addition of as compare to control, might be due to more fibre content in the orange waste. Sample T_3 containing 30 per cent was reported higher crude fibre content. Ash content in all the formulated weaning foods ranged from 2.2 to 4.3 per cent. There was significant and constant amount of fat content in all the formulated weaning foods with increasing the level of orange waste powder from 3.91 to 4.92 g. The highest fat content 4.92 per cent was found in sample T_3 containing 30 per cent combination. Control sample without orange waste having ash content of 2.22 per cent whereas in sample T_3 recorded highest crude fat content which was two folds increases than control. The increase in the level of orange waste combination powder in the weaning food increases the carbohydrates content of weaning food than control

Table 1 : Standardisation of recipe for formulation of weaning food with fortification of orange waste powder (peel and pomace powder in 1:1 proportion) (Ingredients in grams)

Sr. No.	Energy food	Sorghum flour	Rice flour	Green gram flour	Foxtail millet	Orange waste powder
1.	Control	30	20	20	20	-----
2.	T_1	30	20	20	20	10
3.	T_2	30	20	20	20	20
4.	T_3	30	20	20	20	30

may be due to high carbohydrates content in the orange waste. Moreover, sample T_3 was found to be statistically significant over sample T_1, T_2 and control sample. Similar results regarding the increase in proximate constituents with fortification of orange waste Combination powder are reported by Ukey *et al*. (2014).

Organoleptic evaluation of formulated weaning food with fortification of orange peel and pomace powder:

Organoleptic characteristics are pivotal in judging the suitability of product as consumer point of view. In order to study the effect orange waste fortification on sensorial quality characteristics, different random trials with wide range of fortification levels has been taken following the unorganized sensorial evaluation. It was observed that weaning food containing more than 15 per cent of orange waste fortification were not acceptable by panel members. Hence, for further optimization of orange waste fortification level in weaning food, organized trials were taken by incorporating different levels *viz*., 5, 10 and 15 per cent of orange waste (mixture of orange peel powder and pomace powder in equal quantity). The data pertaining to organoleptic quality evaluation of product is presented in Table 3.

Organoleptic evaluation of the three formulated weaning foods with fortification of 10, 20 and 30 per cent of orange waste combination powder was undertaken on the basis of sensory characteristics such as colour, flavour, taste, texture and overall acceptability on nine point hedonic scale. The mean score of different oraganoleptic characteristics of the weaning food formulations are summaried in the Table 3. It is clear from the table that as the level of orange waste increases, the organoleptic score was increased upto 20 per cent and decreased after that. The sample T_3 containing 30 per cent orange waste combination powder, though containing more nutritional profile, but least accepted. The overall acceptability of sample T_2 was found to be significantly more than sample T_3, though not much difference was observed when compare to sample T_1. And this formed the basis for selection of this formulation of sample T_2 containing 20 per cent orange waste combination powder for further studies.

Effect of pre treatments (malting and roasting) on organoleptic evaluation of selected formulated orange waste combination powder based weaning food. The pre treatments such as malting and roasting are given to the above selected weaning food (sample T_2) for improving their organoleptic characteristics resulted into its acceptability. The mean score of different organoleptic characteristics are presented in Table 4. It is evident from table that the malting process of procured grains improved the organoleptic characteristics of prepared weaning food. Malted weaning food (MW1) and control sample without

Table 2 : Proximate composition of weaning food with fortification of orange peel powder and pomace powder

Sr. No.	Weaning food	(% composition)					
		Moisture	Protein	Fat	Dietary fibre	Ash	Carbohydrate
1.	Control (C)	3.98	13.05	3.91	10.08	2.22	70.01
2.	T_1	3.58	13.71	4.07	11.10	2.57	71.88
3.	T_2	3.31	15.05	4.41	12.2	3.28	73.52
4.	T_3	3.08	17.07	4.92	13.02	4.38	74.85
	S.E.±	0.008	0.004	0.006	0.07283	0.003	0.007
	C.D. (P=0.05)	0.026	0.014	0.018	0.21924	0.011	0.022

Table 3 : Organoleptic evaluation of formulated weaning food with fortification of orange peel powder and pomace powder

Sr. No.	Weaning food	Colour and appearance	Flavour	Texture	Taste	Overall acceptability
1.	Control	8.1	8.0	8.0	8.0	8.0
2.	T_1	8.3	8.2	8.2	8.3	8.2
3.	T_2	8.4	8.8	8.4	8.6	8.5
4.	T_3	8.0	8.5	7.0	7.2	7.8
	S.E.±	0.020	0.035	0.023	0.039	0.070
	C.D. (P=0.05)	0.061	0.106	0.071	0.117	0.212

Control- Without addition of orange peel and pomace
T_1 - With addition of 10 per cent of orange peel and pomace
T_2 - With addition of 20 per cent of orange peel and pomace
T_3 - with addition of 30 per cent of orange peel and pomace

orange waste combination powder are found to be almost similar in all the organoleptic characteristics as they did not differ significantly on the basis of critical difference. The formulated weaning food (sample T_2) and roasted weaning food (RW1) were rated lower score indicated their least acceptability. Malted weaning food (MW1) was rated highest overall acceptability score (8.3) where as roasted one rated lowest (7.8), control, sample T_2, malted and roasted energy foods had almost similar texture and as were statically at par with each other. Malted and control sample were comparable for the taste while roasting of grains improve the flavour of weaning food but recorded least score in other remaining organoleptic characteristics. The malted weaning food was rated highest and indicated that it was having good texture as compare to other weaning foods. The casual reason would be the viscosity of the weaning food during serving with the milk which had shown the drastic reduction due to the malting treatment enhance it would be preferred by the judges. In all among the four developed weaning foods, the malted food was superior yielding a good quality product. However on the basis of critical difference there was not much difference observed in malted, roasted and control sample in all organoleptic attributes except flavour.

A number of scientists reported the improvement in the organoleptic characteristics of malted product. Desai *et al*. (2010) reported the increase in the intensity of colour in sample prepared from malted grains. Softing of texture in sample was mainly due to the effect of germination of grain (Beal and mottram, 1993). Germination of grains which contains free amino acids and sugar which act as flavour precursors Heinieo *et al*. (2015) .

Nutritive values of organoleptically accepted orange waste combination powder based weaning foods are reported. In previous study malted weaning food and earlier sample T_2 are selected for analysis of their nutritive quality and the results are tabulated in Table 5. It can be seen from table that protein, fat, crude fibre and ash were slightly decreased in the malted weaning food than sample T_2. The moisture content increased singnificantly in malted weaning food (MW_1) over sample T_2. Which is a normal indication of rapid water uptake by viable grain accepted during steeping The protein content of sample T_2 was 15.05 per cent and malted sample reported 15.00 per cent, this slight reduction could be because of the leaching out of the soluble protein and removal of rootlets thereby reducing the total dry material during malting and also another probable reasons is that storage nitrogen reserves may have been mobilized during sprouting after hydrolysis by proteolytic enzymes. Ogbonna *et al.* (2012). The data on the decrease in the protein content during malting are fairly consistent with those of Taylor (1983). Who observed significant decrease in the protein content in the sorghum during malting. The fat content of sample T_2 was noted to be highest (4.41 %) and that of the developed malted weaning foods containing 4.02 per cent

Table 4 : Effect of pre-treatments on organoleptic evaluation of selected formulation of orange waste based weaning food (Sensory attributes on 9 point hedonic scale)

Sr. No.	Pre treatments	Colour	Flavour	Taste	Texture	Overall acceptability
1.	Control sample II	8.0	6.5	7.9	8.0	8.0
2.	M_1	8.2	8.2	8.1	8.1	8.3
3.	R_1	7.9	8.5	8.0	7.9	7.8
	S.E. ±	0.10	0.05	0.09	0.07	0.08
	C.D. (P=0.05)	0.30	0.17	0.29	0.23	0.26

Sample II: recipe with 20per cent Orange waste combination powder based weaning food
M_1: malting of grains with 20per cent Orange waste combination powder based weaning food
R_1: roasting of grains with 20per cent Orange waste combination powder based weaning food

Table 5: Proximate composition of organoleptically accepted weaning food of orange waste (peel and pomace powder 1:1)

Sr. No.	Orange waste based weaning food	Moisture	Protein	Fat	Dietary fibre	Ash	Carbohydrate	Energy
1.	Control sample T_2	3.31	15.05	4.41	12.2	3.28	73.52	382
2.	M_1	4.10	15.00	4.02	16.5	2.9	71.11	401
	S.E. ±	0.0236	0.6953	0.231	0.400	0.2412	0.497	0.9428
	C.D. (P=0.05)	0.071	2.031	0.695	1.206	0.725	1.497	2.8381

Sample II: recipe with 20per cent orange waste combination powder based weaning food
M_1: malting of grains with 20per cent orange waste combination powder based weaning food

fat. The reduction in the fat content of malted weaning foods was also reported by Kumari and Srivastav (2000) that hydrolysis of lipids and oxidation of fatty acids takes place during germination. The hydrolysis products do not accumulated in the seed, but glycerol becomes a part of carbohydrate pool and fatty acids are oxidized resulting in decrease fat in malting. The dietary fibre content was significantly increased (16.5 %) in malted weaning food (MW_1) as compared with sample T_2. This increase in dietary fibre might be due to synthesis of structural carbohydrates mainly of cellulose, lignin and hemicelluloses, this increase could be attributed to increased bran matter and building of dry matter during the germinatior of grain. Similar results were reported by Eggum *et al.* 1981 and Chavan and Kadam (1989). The total ash content of the malted sample decreased from the sample T_2. The carbohydrate content in the malted sample shows a tendency of reduction during malting.The most probable reason of its reduction was undoubtedly the increase in endogenious $\alpha - \beta$ amylase during malting which hydrolyse the starch. Similar result are also reported by Pathirana *et al.* (1983). As far as statistical analysis concern there was not much difference observed in both the samples on the basis of critical difference. Similar result are also reported by Bhise *et al.* (1996) and Elkhier and Hamid (2008).

The results on physical properties of developed weaning foods are narrated in Table 6. The particle density values of weaning foods *viz.*, sample T_2, malted and market sample were 0.528 ,0.510 and 0.78 g/ml. The dispersability was recorded to be highest (55.7 %) in malted weaning food and lowest (31.4 %) in control sample whereas the market commercial food was almost intermediate (45.02 %). The malted weaning food had the lowest density and water absorption capacity and high dispersability which were the desirable properties of product Kapoor and Gupta (1981).Water absorption capacity was expressed in terms of g of water/g of weaning foods and is resultant of water binding nature of protein and carbohydrate Kinsella and Shetty (1979) and Deshpande *et al.* (1982) and this can be revealed in the water absorption capacity of the prepared sample. Water absorption capacity of control sample T_2 was recorded (112g/100g) and in malted it was (108g/100g) and market sample reported (111g/100g).

The observation from Table 7 revealed that the mineral content in the malted weaning food (MW_1) are decreased over sample T_2. The Calcium content of sample T_2 was more (162 mg) as compare with malted sample (102 mg). Similar trend of reduction of other minerals are also observed in malted sample as compare to sample T_2. The mineral content of all millets was decreased in malting. It may be due to leaching and mobilization of mineral elements from storage tissues to the developing seedling. Results were in conformity with findings of Waniska and Rooney (2002). During malting the bioavailability of all minerals increases with slightly decrease in mineral content in malting process. As far the mineral element level the result showed a marked decreased in almost all the mineral compositional content

Table 6: Functional characteristics of orange waste based weaning food

Sr. No.	*Moringa oleifera* based energy food	Density (g/ml)	Dispersability (%)	Water absorption capacity (g/100g)
1.	Control sample T_2	0.528	31.4	112
2.	M_1	0.510	56.7	108
3.	Market sample	0.78	45.02	111
	S.E. ±	0.064	0.4857	0.9686
	C.D. (P=0.05)	0.1926	1.462	2.9159

Sample T_2: recipe with 20per cent orange waste combination powder based weaning food
M_1: malting of grains with 20per cent orange waste combination powder based weaning food

Table 7 : Minerals composition of organoleptically accepted orange waste based weaning food (mg per 100g)

Sr. No.	Orange waste based weaning food	Calcium	Magnesium	Phosphorus	Iron	Potassium
1.	Control sample T_2	162	86.5	107	9.0	1062
2.	M_1	102	75.2	71	6.1	950
	S.E. ±	0.7071	0.4714	0.9428	0.2357	0.7171
	C.D. (P=0.05)	2.1286	1.491	2.8381	0.7095	2.1515

Sample T_2: recipe with 20per cent Orange waste combination powder based weaning food
M_1: malting of grains with 20per cent Orange waste combination powder based weaning food

of the processed grain when compared with raw. This is because during various processing techniques the pericarp of some grain are removed while the grain break open also aleurone layer of some of these cereals are lost thus resulting in this massive decrease. This also because almost minerals element are found on either the pericarp or the aleurone layer of the grain Gee and Harold (2004).

Conclusion :

Orange (*Citrus sinensis*) waste combination powder based weaning food was developed by varying different levels (10, 20 and 30 %) in the standardized recipe. The proximate composition of orange waste combination powder based weaning food revealed that all the proximate constituents are considerably increased as the level of orange waste combination powder increased. Out of the three formulation studies, the sample T_3 was found richest in the protein (17.07 %) and fat (4.92 %) containing 30 per cent orange waste combination powder. The mean score of different oraganoleptic characteristics of the weaning food formulations showed that sample T_2 containing 20 per cent orange waste combination powder was significantly superior over sample T_1 and T_3 though the sample T_3 containing more nutritional profile, but least accepted. The pre treatments such as malting and roasting are given to the above selected weaning food (sample T_2) for improving their organoleptic characteristics and the results revealed that among the four developed weaning foods, the malted food was organoleptically superior yielding a good quality product. The results on physical properties of developed weaning foods showed that the malted weaning food had the lowest density and water absorption capacity and high dispersibility of weaning foods are the desirable properties of product.

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