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Formulation and acceptability of blended weaning food by incorporating banana, sweet potato and drumstick leaves powder

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Abstract
The weaning period is a crucial period in an infant's life. At the age of 5–6 months, most infants begin to eat supplementary semisolid foods. At this stage homogenized infant foods play a major role in their nutrition. In developing country like India hidden hunger is one of the main problem due to deficiency of micronutrients like vitamins and minerals especially vitamin A, iron and zinc. Cereal gruel is the common complementary foods in developing countries, and it is usually low in energy and protein, thus increase in protein-energy malnutrition among underprivileged weaning aged children. In this context, the present experiment was conducted to formulate weaning food (7 treatments) for infants from malted wheat flour, malted ragi flour, malted green gram flour, roasted flax seed powder blended with banana, sweet potato and drumstick leaves powder. The formulated samples were analyzed for physico-chemical and sensory attributes The sensory analysis revealed that the weaning food mix with 30% banana powder, 10% sweet potato powder, 5% drumstick leaf powder had good sensory qualities in terms of overall acceptability (7.77).

Keywords: Formulation, acceptability, blended weaning food, incorporating, banana, sweet potato, drumstick leaves powder

Introduction
Weaning is defined as the process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk (Onis *et al.*, 1993) [1]. It is also called 'complementary feeding' as these food complemented with breastfeeding. During the critical period of an infant's growth and development which is the weaning stage in infancy (6 and 24 months), a transition in administration of diet occurs from a diet based on mother's milk to another diet which is usually semi-solid to a more solid diet. The mothers' milk or any other form of milk is sufficient for a newborn baby and starts getting insufficient for some essential elements of nutrition beyond six months of age. At this stage, it becomes necessary to introduce other foods into the infant diets to meet the nutritional requirement of the child, especially for energy and micronutrients, notably iron, zinc, calcium, vitamins (A, C, B group etc.)

Banana (*Musa paradisiaca* L.) belongs to the family Musaceae. It is grown in an area of 858.1 thousand ha, with a production of 29162.6 MT and productivity of 34 MT/ha (Anon, 2016) [2]. In Karnataka, it is being grown in an area of 74.68 thousand ha with a production of 3072.49 MT (Anon, 2016) [2]. The primary product of banana in market is "fried chips and candy" which constitute around (31%), rest as banana puree (9%), banana pulp (3%), banana beer (3%), banana wafers (3%), banana powder (6%) and others (Rashmi and Jyothsna, 2011) [3]. Banana is a highly perishable fruit thus it is necessary to develop shelf stable products such as banana powder, dried slices, jam, baby food etc. (Patel *et al.*, 1999) [4].

Bananas are one of the best sources of potassium, an essential mineral for maintaining normal blood pressure and heart function and act as a energy booster. The fruit has a mild laxative property. It is used as a remedy for constipation in children. It is believed to be helpful in curing diarrhea and dysentery. It forms the part of diets of children suffering from malnutrition. A mashed ripe banana is an extremely simple and healthy baby food. It contains high amount of potassium, fiber, calcium, magnesium, phosphorus, selenium, iron, Vitamins A, B_2, B_6, C, E, niacin, folate, and pantothenic acid. Furthermore, bananas are very easy to digest and rarely cause allergic reactions (Kumar *et al.*, 2013) [5].

Sweet potato (*Ipomoea batatas* L.) belongs to the family *Convolvulaceae*. In India, it is grown in an area of 134.9 thousand hectares with a production of 1638.8 MT and 12.2 MT/ha (Anon, 2016) [2]. In Karnataka it is grown in an area of 2.54 thousand hectares and production of 36.02 MT (Anon, 2016). β-Carotene from sweet potato is substantially better (in terms of bioavailability) than that from leafy vegetables or other vegetables. It is also a valuable medicinal plant having anti-cancer, anti-diabetic, and anti-inflammatory activities (Mohanraj and Sivasankar, 2014) [6]. Protein contents of sweet potato leaves and roots range from 4.0 to 27.0 percent and 1.0 to 9.0 percent, respectively. The sweet potato could be considered as an excellent novel source of natural health-promoting compounds, such as β-carotene and anthocyanins (Bovell-Benjamin, 2007) [7].

Drumstick is widely cultivated in tropical and subtropical areas where its young seed pods and leaves are used as vegetables. It is grown for its nutrient rich tender, but full grown pods, leaves and flowers which are used for culinary preparations. Extracts from the leaves are used to treat malnutrition, augment breast milk in lactating mothers. It is used as potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antimicrobial agent (Gopalakrishnan *et al.*, 2016) [8]. Drumstick leaves are reported to contain substantial amounts of vitamin A, C and E. The leaves of drumstick also contain appreciable amounts of total phenols, proteins, calcium, potassium, magnesium, iron, manganese and copper (Hekmat *et al.*, 2015) [9]. The powder will also find suitable application in preparation of weaning food, ready to eat foods, instant *Sambhar* mix, soup powder, juice, chutney and pickle.

Traditionally weaning food has been based on local staple food, usually a cereal and it is either made into a thick porridge or liquid gruel, which is not only unpalatable but also more viscous and difficult for child to swallow. On the other hand, addition of more liquid results in dilution of nutrients. This along with low feeding frequency leads to low food intake and subsequently lead to the malnutrition (Mehta and Shah, 2001) [10]. Cereal–legume blends, processed at the household level, are not fortified with mineral or vitamin premix hence, their micronutrient content (particularly of vitamin A) is likely to be low, which contributes to the high prevalence of vitamin A deficiency in low-income countries where infants are fed such complementary foods (Gibson *et al.*, 2010) [11]. Ready mix weaning foods available in the market are costly and cannot be afforded by majority. Formulation of low-cost and highly nutritious food supplement for weaning infants is a constant challenge. This is particularly important in developing countries where malnutrition problems are still common particularly during weaning (Temesgen, 2013) [12].

A study was therefore designed to develop nutrient-dense, safe, low cost weaning food from the combination of wheat, ragi, greengram, flax seed and incorporated with banana, sweet potato and drumstick leaves powder in order to evaluate its acceptability through organoleptic evaluation.

Material and methods

Procurement and processing of raw materials

Unripe but mature bananas of cultivar 'Grand Naine' were procured from the local market, Bagalkot in batches to avoid ripening. Sweet potato powder from the cultivar 'Sri Hari', a released variety from AICRP on tuber crops, RHREC, Kumbapur Farm, Dharwad and the leaves of KDM-01 (Bhagya) a newly released drumstick variety of University of Horticultural Sciences, Bagalkot were used for the study. Other ingredients such as wheat, ragi, greengram and flax seeds were purchased from the grocery shop local market, Bagalkot.

Preparation of banana powder

Mature green bananas were selected, washed and the fruits were peeled to obtain pulp. After separation from the peel, the pulp was cut into slices and fumigated with sulfur @ 2g/kg for 10 minutes. After pretreatment, the slices were placed in a tray drier at 60 ^{0}C for 6 hours to obtain dried slices. The dried banana slices were crushed by food grinder into powder form to completely pass through 60 mm size sieve. Unripe banana powder was packed in aluminum foil pouches for incorporating it into weaning mix.

Preparation of drumstick leaves powder

Fresh drumstick leaves were procured from the trees of drumstick variety KDM-01 (Bhagya) plantation maintained by Main Horticulture Research and Extension Centre, UHS, Bagalkot at Sector No.1. The twigs containing half matured drumstick leaves were taken to laboratory. The leaves were separated from twigs, washed thoroughly in clean running water, drained and spread on the clean stainless steel tray to remove surface moisture. After removal of surface moisture leaves were weighed and dried under electrical tray drier at 60˚C until they were crisp. Dried drumstick leaf powder was packed separately in LDPE bags (200 gauze) for further use.

Preparation of malted wheat flour

The whole malted wheat flour was prepared as per the procedure of Taragopal *et al.* (1982) [13]. Good quality wheat was cleaned and soaked in clean water for 12 h. Then water was drained out and kept for germination for 36 h at room temperature covered with wet cloth, followed by shade drying till the grain becomes dry completely. Dried wheat was devegetated to remove rootlets and roasted for 15 min. The germinated dried wheat was ground to obtain malted wheat flour. The flour thus obtained was sieved using 60 mm mesh sieve and stored in LDPE bags until used.

Preparation of malted ragi flour

Ragi malt flour was prepared as per the procedure described by Swamy (2003) [14] with slight modification. A good quality ragi was cleaned and soaked in clean water for 16 h followed by draining out the water. Further, it was held for germination for 36 h in wet cloth and sprinkling with water at regular interval. After germination, it was shade dried until they become crisp. Devegetation was done to remove rootlets. Further, it was roasted for 15 min to improve the flavor followed by grinding to fine powder. The powdered ragi malt was sieved using 60 mm mesh sieve and stored in LDPE bags until used.

Preparation of malted green gram flour

The green gram malt was prepared as per the procedure outlined by Malleshi (1995) [15]. A good quality green gram procured from the local market was cleaned and soaked in clean water for 12 h. Further, water was drained and kept for germination for 24 h at room temperature covering with wet cloth, followed by shade drying till the grains become crisp. Sprouted dried green gram was devegetated and dehusked to obtain malted dhal. The dhal was roasted for 15 min followed by grinding to get fine powder. The flour thus obtained was sieved using 60 mm mesh sieve and stored in LDPE bags for further use.

Preparation of roasted flax seed powder

Roasted flax seed powder is prepared by using good quality flax seeds which are cleaned and roasted for three minutes at low heat by stirring gently every few seconds. As the flax seeds tends to pop and release characteristic aroma, heating is stopped. The seeds are cooled and and ground to obtain powder, packed in LDPE bags and sealed for further usage in the investigation.

Formulation of weaning mix

The unripe banana, sweet potato, drumstick leaves powder, malted wheat, ragi and green gram flours and roasted flax seed powder were used for preparation of weaning mix. Only the malted wheat flour was replaced by different levels of unripe banana powder *i.e.*, 25, 30, 35, 40, 45 and 50 percent.

Treatment details

Treatments: 7
Design: Completely randomized design
Replications: 3
Raw material: Unripe banana, sweet potato powder drumstick leaves, wheat, ragi and green gram and flax seed
Sample size: 100 g per treatment

Table 1: Recipe of different treatments for weaning mix incorporated with banana, sweet potato, drumstick leaves powder

Ingredients	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Malted wheat flour (g)	10	15	20	25	30	35	35
Malted ragi flour (g)	10	10	10	10	10	10	30
Malted green gram flour (g)	10	10	10	10	10	10	30
Roasted flax seed powder (g)	5	5	5	5	5	5	5
Banana powder (g)	50	45	40	35	30	25	0
Sweet potato powder (g)	10	10	10	10	10	10	0
Drumstick leaf powder (g)	5	5	5	5	5	5	0

Sensory evaluation

Porridge was prepared by taking 10 g sample from each treatment mixed with 25 ml water and makes it in to paste. The paste was poured to 75 ml water along with 10 g jaggery and it was cooked until semi-solid paste is obtained. They were kept in hot boxes and used for sensory evaluation.

Sensory evaluation of weaning food by incorporation of banana powder, sweet potato and drumstick leaves powder was carried out by 10 semi trained panel consisting of a Teacher and Post-Gratuate students of College of Horticulture, Bagalkot with the help of nine point hedonic scale (1= dislike extremely, 2= dislike very much, 3= dislike moderately. 4= dislike slightly, 5= neither like nor dislike, 6= like slightly, 7= like moderately, 8= like very much and 9= like extremely) for colour, flavor, taste, consistency and overall acceptability (Swaminathan, 1974) [16]. The products along with control were coded and served randomly to the panelist for sensory evaluation immediately after preparation.

Statistical analysis

The data were statistically analysed in complete randomized design for analysis of variance, mean, standards deviation and critical difference according to the standard methods. The level of significance used in F and t test was at one percent level of significance.

Results and discussion

Colour and appearance is the first thing that catches the consumer's attention and remaining aspects stand next to this parameter. The colour of the food product is the main interest of consumers and its value in sensory evaluation is very subjective (Soekartio, 1981) [17]. There were no significant differences observed for colour and appearance of prepared weaning food (Table 2). Maximum colour score (7.72) was recorded in T_6 [Malted wheat flour (40%)+ malted ragi flour (10%)+ malted green gram flour (10%)+ banana powder (25%) + sweet potato flour (10%)+ drumstick leaves powder (5%) + roasted flax seed powder (5%)]. Whereas, the minimum score (7.20) for colour and appearance was recorded in T_7 [Malted wheat flour (35%)+ malted ragi flour (10%)+ malted green gram flour (30%) + roasted flax seed powder (5%)]. No significant difference was observed with respect to colour by Ghavidel and Davoodi, (2011) [18] in wheat + greengram, wheat + lentil, rice + green gram and rice + lentil based weaning food.

Flavour scores of prepared weaning food differed significantly among the treatments. Significantly maximum score (7.91) for flavour was recorded in T_5 [Malted wheat flour (30%)+ malted ragi flour (10%)+ malted green gram flour (10%)+ banana powder (30%) + sweet potato flour (10%)+ drumstick leaves powder (5%) + roasted flax seed powder (5%)] and it was on par with T_6 (7.72) (Table 2). The minimum mean score for flavor was recorded in control (T_7) [Malted wheat flour (35%)+ malted ragi flour (10%)+ malted green gram flour (30%) + roasted flax seed powder (5%): 6.01]. The lowest score obtained in T_7 might be due to the difference in the basic ingredients. The weaning food was well accepted by the incorporation of sweet potato, drumstick and banana powder (upto 30%) but beyond 30 percent of banana powder significantly reduced the flavour scores. Similar findings were observed by Ayo-Omogie and Ogunsakin, (2013) [19] where the weaning food with 50:50 maize-banana flour mix was most preferred for its flavour.

Taste scores of weaning food differed significantly among the treatments (Table 2). This difference in taste of different treatments may be due to human perception. The maximum score for taste was recorded in T_5 [Malted wheat flour (30%)+ malted ragi flour (10%)+ malted green gram flour (10%)+ banana powder (30%) + sweet potato flour (10%)+ drumstick leaves powder (5%) + roasted flax seed powder (5%) : 8.00]. This might be due to the mild taste of banana up to 30 percent which was much liked by the panelist. The minimum score for taste was recorded in T_7 (6.53). The results are in harmony with the findings of Adebayo-Oyetoro *et al.* (2012) [20] who reported that the sample prepared from sorghum flour incorporated with 25 percent walnut and 5 percent ginger were most accepted for taste.

Table 2: Effect of new weaning food formulation on sensory scores for colour and appearance, flavour and taste of weaning food

Treatments	Colour * and appearance	Flavour *	Taste *
T_1: MWF (10%) +MRF (10%) +MGF (10%) + BP (50%) + SPP (10%) +DLP (5%) +RFP (5%)	7.54	6.92	7.14
T_2: MWF (15%) +MRF (10%) +MGF (10%) + BP (45%) + SPP (10%) +DLP (5%) +RFP (5%)	7.50	6.81	7.19
T_3: MWF (20%) +MRF (10%) +MGF (10%) + BP (40%) + SPP (10%) +DLP (5%) +RFP (5%)	7.63	6.84	6.45
T_4: MWF (25%) +MRF (10%) +MGF (10%) + BP (35%) + SPP (10%) +DLP (5%) +RFP (5%)	7.49	7.10	7.21
T_5: MWF (30%) +MRF (10%) +MGF (10%) + BP (30%) + SPP (10%) +DLP (5%) +RFP (5%)	7.67	7.77	8.00
T_6: MWF (35%) +MRF (10%) +MGF (10%) + BP (25%) + SPP (10%) +DLP (5%) +RFP (5%)	7.72	7.59	7.80

T_7: MWF (35%) +MRF (30%) +MGF (30%) +RFP (5%)	7.20	6.01	6.53
Mean	7.54	7.00	7.17
SEm±	0.18	0.19	0.10
CD at 1%	NS	0.81	0.48

MWF: Malted wheat flour **MRF**: Malted ragi flour **MGF:** Malted greengram flour **BP:** Banana powder
SPP: Sweet potato powder **DLP:** Drumstick leaf powder **RFP:** Roasted flax seed powder

Flour (10%)+ malted ragi flour (10%)+ malted green gram flour (10%)+ banana powder (50%) + sweet potato flour (10%)+ drumstick leaves powder (5%) + roasted flax seed powder (5%) :7.23). However, there was no significant difference between samples. Adenuga, (2010) [21] reported no significant differences observed within different treatments with respect to texture in sweet potato based weaning food fortified with cowpea and peanut and existence of non significant difference for texture was also reported in wheat+ greengram, wheat+ lentil, rice+green gram, rice+lentil based weaning food (Ghavidel and Davoodi, 2011) [18].

Table 3: Effect of new weaning food formulation on sensory scores for texture and overall acceptability of weaning food

Treatments	Texture * (mouth feel)	Overall * acceptability
T_1: MWF (10%) +MRF (10%) +MGF (10%) + BP (50%) + SPP (10%) +DLP (5%) +RFP (5%)	7.23	7.21
T_2: MWF (15%) +MRF (10%) +MGF (10%) + BP (45%) + SPP (10%) +DLP (5%) +RFP (5%)	7.33	7.20
T_3: MWF (20%) +MRF (10%) +MGF (10%) + BP (40%) + SPP (10%) +DLP (5%) +RFP (5%)	7.59	7.12
T_4: MWF (25%) +MRF (10%) +MGF (10%) + BP (35%) + SPP (10%) +DLP (5%) +RFP (5%)	7.47	7.32
T_5: MWF (30%) +MRF (10%) +MGF (10%) + BP (30%) + SPP (10%) +DLP (5%) +RFP (5%)	7.77	7.81
T_6: MWF (35%) +MRF (10%) +MGF (10%) + BP (25%) + SPP (10%) +DLP (5%) +RFP (5%)	7.64	7.68
T_7: MWF (35%) +MRF (30%) +MGF (30%)+RFP (5%)	7.65	6.85
Mean	7.53	7.31
SEm±	0.16	0.13
CD at 1%	NS	0.50

MWF: Malted wheat flour **MRF**: Malted ragi flour **MGF:** Malted greengram flour **BP:** Banana powder
SPP: Sweet potato powder **DLP:** Drumstick leaf powder **RFP:** Roasted flax seed powder

Significantly maximum score (7.76) for overall acceptability was recorded in T_5 [Malted wheat flour (30%)+ malted ragi flour (10%)+ malted green gram flour (10%)+ banana powder (30%) + sweet potato flour (10%)+ drumstick leaves powder (5%) + roasted flax seed powder (5%)] and it was on par with T_6 [Malted wheat flour (40%)+ malted ragi flour (10%) + malted green gram flour (10%)+ banana powder (25%) + sweet potato flour (10%)+ drumstick leaves powder (5%) + roasted flax seed powder (5%): 7.68) and T_4 [Malted wheat flour (25%) + malted ragi flour (10%) + malted green gram flour (10%) + banana powder (35%) + sweet potato flour (10%) + drumstick leaves powder (5%) + roasted flax seed powder (5%):7.32] could be due to mild flavour of banana along with sweet potato and drumstick imparting good flavour and taste which in turn resulted in higher overall acceptability scores (Table 3). The minimum score for overall acceptability was recorded in treatment T_7 (6.85). Similar results are also reported by Adenuga (2010) [21] where weaning food was prepared from sweet potato flour (60%), cowpea flour (25%), peanut flour (15%). Samples with 25% walnut and 5% ginger as reported by Adebayo-Oyetoro *et al*. (2012) [20] had highest overall acceptability. Ghavidel and Davoodi (2011) [18] noticed that the wheat+ green gram based weaning food had highest score (6.62) for overall acceptability and weaning food with malted wheat flour: malted lentil flour: potato (45:25:15) had highest mean score and general acceptability.

Conclusion

From this study it was concluded that weaning food mix with 30% banana powder, 10% sweet potato powder, % drumstick leaf powder had good sensory qualities in terms of overall acceptability (7.77).

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