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DEVELOPMENT OF PULSE, BANANA AND PINEAPPLE POMACE BASED WEANING FOOD AND ITS QUALITY EVALUATION DURING STORAGE

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ABSTRACT

The present research was carried out with the objective to develop weaning food using different levels of pulse flour, banana flour and pineapple pomace flour with respect to sensory quality and nutritional density and evaluated for its physico-chemical, sensory and microbial characteristics. Weaning foods were packed in laminated aluminium foil, and were stored at ambient temperature. Eight blends, prepared with banana flour 30%, pulse flour and pineapple pomace flour were incorporated in the ratio 70:0, 65:5, 60:10, 55:15, 50:20, 45:25, 40: 30, 35:35. The result indicated that a ratio of 50:30:20 percent pulse, banana and pineapple pomace respectively was optimal incorporation. The optimal value of moisture content was 3.87%, ash content 4.28%, fat content 2.1%, protein content 22.51% and ascorbic acid was 37.35 mg per 100g. During storage ash, protein, fat, and ascorbic acid decreases with increasing storage period. The sensory score of colour, flavor, taste, and texture was decreased slightly during storage. The microbial count was noticed 100 – 200 plate count/ 100g, the level fell far below the ISO recommended value i.e. 50,000 plate count/ 100g.

INTRODUCTION

Mother's milk constitutes nature best food. It is considered as the most suitable food for newborn infants since time immemorial. It is the natural security provided for the survival of the infants. Although majorities of Indian babies are breast-fed during the first 6-8 month of life (Gopalan *et al*., 1962), not everybody is fortunately in having a healthy mother who could provide adequate nutrition. Thus arises the need for baby and weaning foods. A baby has specific nutritional need for protein, fat, carbohydrate, minerals and vitamins.

The report by UNICEF, 1988, indicated that breast milk, even from well-nourished mothers, might be inadequate to meet the nutritional needs of the infant after the first three months of life; hence the need for a supplementary or weaning food. This weaning period is a very critical period in the life of a child and if not well managed, might lead to malnutrition and other health implications (Tontisrin *et al*., 1981; Pedersen *et al*, 1989; Keithod and Udipo, 1999 and Ozumba *et al*, 2002).

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Complementary feeding, i.e. introduction of foods other than milk to an infant's diet, is a major step in the development of food behavior, it represents a critical stage from both nutritional and behavioural standpoints, likely to affect the infant's growth and health (Greer *et al*., 2008; Morgan *et al.*, 2004; Zutavern *et al.*, 2008 and Sloan *et al.*, 2008).

Complementary feeding is generally started because milk is no longer nutritionally sufficient, thus many studies related to complementary feeding have focused on nutritional aspects. Most babies need extra food beside breast milk as they grow fast and breast milk is no longer enough to support their growth (Srivastava, 2002).

According to the National Family Health Survey of India, 48% of children in India are malnourished. 55% of children living in rural areas suffer from malnutrition compared to 45% of children in urban areas. The situation is particularly grave in states like Bihar, Uttar Pradesh, Madhya Pradesh and Rajasthan. According to the Indian Council of Media Research, there is a great lack of nutrition with many leaving out the most crucial nutrients from their diet (Blakeman, 2005).

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 (Cameroon and Hofvander, 1971; Berggren, 1982; Sajilata *et al*., 2002; Umeta *et al.*, 2003). Thus, weaning food plays a vital role in the all round growth, development and mental health of children. The interventions were carried out to introduce cassava made semisolid diet for weaning children for six months before shifting them to solid diet. Results show complete eradication of malnutrition and control over the diarrhoea (Takele, 2009).

Apart from protein and energy, weaning diets of infants in developing countries require more calcium, vitamin A, C and D, iron and some important trace elements. These can be obtained by combining the local staples presently available in the country. Combination of commonly used cereals with inexpensive plant protein sources like legumes can be used. Cereals are deficient in lysine but have sufficient sulphur containing amino acids which are limited in legumes (Tsai *et al*., 1975; Wang and Daun, 2006; Iqbal *et al*., 2006; Shewry, 2007) whereas legumes are rich in lysine.

Mung bean is an excellent source of protein (27%), and its essential amino acid composition compares favourably with that of soybean, kidney bean and FAO/WHO reference protein (El-Adawy, 1996; Fan & Sosulski, 1974; Thompson, Hung, Wang, Rapser, & Gade, 1976). Mung bean are rich in minerals and vitamins. Chemical composition include proteins, fatty acids, carbohydrates, Vitamin B1, B2, beta carotene, folic acid, calcium, phosphorus and irons. Proteins are rich in lysine, leucine and threonine.

Banana flour prepared from ripe banana containing a quantity of sugar is suitable for incorporation into food products requiring solubility, sweetness and high energy content. Physical properties of fresh banana and banana constituents such as banana starch, have been studied and characterized (Zhang *et al.*, 2005). They are rich in vitamin B6 and they are a good source of fiber, vitamin C, magnesium and potassium. Vitamins and minerals are abundant in the banana, offering 123 I.U. of vitamin A for the large size. Banana also has a full range of B vitamins with 0.07 mg of Thiamine, 0.15 mg of Riboflavin, 0.82 mg Niacin, 0.88 mg vitamin B6, and 29 µg of Folic Acid. There is even 13.8 mg of vitamin C. On the mineral scale Calcium counts in at 9.2 mg, Magnesium 44.1 mg, with trace amounts of iron and zinc. Putting all of the nutritional figures together clearly shows the banana is among the healthiest of fruits. The plantain, when cooked, rates slightly higher on the nutritional scale in vitamins and minerals but similar to the banana in protein and fiber content (Sharrock, 2000).

Pineapple is a popular tropical fruit high in vitamin C and antioxidants. Pineapple is a digestive aid and a Natural Anti-Inflammatory fruit. Pineapples are filled with valuable nutrient such as manganese, vitamin B-1, vitamin B-6, vitamin A, vitamin C, potassium, iron, phosphorus, calcium, copper, dietary fibre and the unique enzyme called Bromelain, a proteolytic enzyme (enzymes that digest protein). In light of above discussion, a study on the development of weaning food was undertaken with the following objective

- To develop pulse, banana and pineapple pomace based weaning food.
- To evaluate the nutritional, physico-chemical and microbiological characteristic of the prepared weaning food.
- To evaluate sensory characteristic of weaning food.
- To evaluate the storage stability of weaning food under laminated aluminium foil.

MATERIALS AND METHODS

The raw materials required for the preparation of baby foods were procured from the local market of and processed at Food Processing Lab. SHIATS, Allahabad. During processing, pulse was cleaned, sorted, roasted at 80-90°C for 10 min and ground to make flour and sieved. Banana were peeled, sliced, blanched in 2% sodium-metabisulphite at 50°C for 10 min, dried, ground and sieved. Pineapple pomace was blanched in water at 82°C for 2 min, dried, ground and sieved. Eight baby food formulas were prepared from different combinations of pulse and pineapple pomace. Different baby foods were formulated and coded (Table 1).

Table 1. Details of formulation of weaning food sample blends in different ratios

Treatments	Moong Bean Flour (%)	Banana Flour (%)	Pineapple Pomace Flour (%)
T0	70	30	0
T1	65	30	5
T2	60	30	10
T3	55	30	15
T4	50	30	20
T5	45	30	25
T6	40	30	30
T7	35	30	35

Chemical analysis of weaning food

Determination of moisture content: Moisture content was determined by oven-dry method as the loss in weight due to evaporation from sample at a temperature of 105°C. The weight loss in each case represented the amount of moisture present in the sample:

$$\text{Moisture (\%)} = \frac{(\text{Wt of sample} - \text{wt of dried sample})}{\text{Weight of original sample}} \times 100$$

Determination of crude protein: The crude protein content was determined following the micro Kjeldahl method (AOAC, 2005). Percentage of nitrogen (N) was calculated using the following equation:

$$\text{Nitrogen (\%)} = \frac{(S-B) \times N \times 0.014 \times D}{W \times V} \times 100$$

Where D = Dilution factor, T = titre value = (S-B), W = weight of sample, 0.014 = constant value.

Crude protein was obtained by multiplying the corresponding total nitrogen content by a conventional factor of 6.25. Thus, crude protein (%) = % of N × 6.25.

Determination of crude fat: Crude fat was determined by the soxhlet extraction technique followed by AOAC (2005). Fat

content of the dried samples was easily extracted into organic solvent (petroleum ether) at 60 to 80°C and followed to reflux for 6 h. Percentage of fat content was calculated using the following formula:

$$\text{Crude fat (\%)} = \frac{\text{Weight of fat in sample}}{\text{Weight of dry sample}} \times 100$$

Determination of ash: Ash content was determined by combusting the samples in a muffle furnace at 600°C for 8 h according to the method of AOAC (2005):

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Determination of carbohydrate: The carbohydrate content was estimated by the difference method. It was calculated by subtracting the sum of percentage of moisture, fat, protein and ash contents from 100% according to AOAC (2005):

Carbohydrate (%) = 100 – (moisture% + fat% + protein% + ash%)

Determination of total energy: The total energy value of the food formulation was calculated according to the method of Mahgoub (1999) using the formula as shown in the following equation:

Total energy (kcal/100 g) = [(% available carbohydrates × 4) + (% protein × 4) + (% fat × 9)].

Determination of Vitamin C: The ascorbic acid content was calculated according to the method of Ranganna (2007) using the formula as shown in the following equation:

$$\text{Mg of ascorbic acid per 100g} = \frac{\text{Titre} \times \text{Dye factor} \times \text{volume made up}}{\text{Aliquot of extract taken} \times \text{volume of sample taken}} \times 100$$

Microbiological Analysis

Determination of microorganism: Microbiological examination of the weaning foods was performed to assess bacterial, fungal and yeast load under laboratory condition. Standard Plate Count (SPC), fungal and yeast count of the weaning foods were examined according to BAM (1998). Plate count method was employed for the examination of total number of viable microbes present in the sample. Standard plate count (SPC) was estimated by decimal dilution technique followed by pour plate method.

Sensory Analysis

Sensory evaluation: Sensory evaluation for the formulated weaning food was conducted using a nine-point hedonic scale with score ranging from 'Like extremely (9)' to 'Dislike extremely (1)'. The evaluated parameters were flavour (taste and aroma), texture, appearance and overall acceptability.

RESULTS AND DISCUSSION

The present study was carried out for development, quality evaluation and storage behavior of weaning food prepared from moong bean flour, banana powder and pineapple pomace powder. Eight samples were prepared having banana 30% whereas pulse and pineapple pomace powder varied from 75 – 35% and 0 – 35% respectively. The quality of weaning foods so obtained was estimated on the basis of physicochemical characteristics like moisture content, ash content, fat content, protein content, vitamin-C content, microbial characteristics namely total plate count (TPC) and finally sensory characteristics reported on the basis of four sensory attributes viz. colour, aroma, taste and overall acceptability in the powder form. For study on storage behavior of all three different samples of weaning food was packed in laminated aluminium foil. The quality measuring parameters were determined in the fresh condition and also periodically evaluated every after 15 days till 45 days during ambient temperature storage.

The moisture content of all the sample ranged from 3.01 to 5.04% which is lower than the specified amount in (IS 2000 – 2009). Low moisture content of formulations are required for convenient packaging and transport of products (Oduro *et al*., 2007). The ash content of samples ranged from 3.96 to 4.69%, Ash content is an important nutritional indicator of mineral content and an important quality parameter for contamination, particularly with foreign matters (for example pebbles) (Fennema, 1996).

The fat content of all the eight sample was ranged from 1.75 to 2.47% lower than the recommended fat level for weaning foods (Protein Advisory group, 1972) The lower fat content may also have contributed to the increase in the shelf - life of the formulation by decreasing the chances of rancidity (Onuorach and Akijede, 2004). Hence a food sample with high fat content is more liable to spoilage than one with a lower fat content. Protein is one of the most important nutrient required in weaning foods. The high protein content of the formulated weaning foods were contributed by the moong bean. The protein content ranged from 24.17 to 20.95%. According to FAO/WHO (1982), a minimum protein content of 15% is required for maximum complementation of amino acids in foods and growth, thus the formulations satisfy the protein demand of infants (Sanni *et al*., 1999). The calories in an infant's diet are provided by protein, fat and carbohydrates (Harper, 2003). The energy content ranged from 373.04 to 381.55 Kcal/100g which is lower than the minimum energy (483.90 Kcal/100g) recommended in the Codex Alimentarius Standards for weaning/follow up foods (FAO/WHO, 1994). This implies the product would supply the needed energy to meet infant's growth demand. The carbohydrate content was ranged from 65.59 to 68.94%. As per Codex Alimentarius Standards, the carbohydrate levels should be 41.13 to 73.79 g/100 g (FAO/WHO, 1994). Vitamins are substances which are indispensible for the growth and maintenance of good health. Vitamin C content of all the samples ranged from 20.75 to 49.8 mg/100g.

Microbiological analysis: Microbial analysis was conducted on freshly prepared samples to determine if blends are wholesome for consumption. The obtained results revealed that the total viable bacterial count and total yeast and mold count per gram were absolutely nil/g in the all weaning foods analyzed, when packets were opened. A food product for consumption should have microbial count below $1x10^5$ cfu/g.

The International Microbiological Standard recommended limit of bacteria contaminants for food of less than 10^6 cfu/g (Anon, 1974) whereas Rombouts and Nouts (1995) revealed that bacterial counts obtained in plants food were in the order of 12 x 10^7 to 10^8 cfu/g. Low bacteria counts were obtained as a result of high standard of personal hygiene, adequate thermal process and good quality of raw materials.

Sensory analysis: Weaning food samples were evaluated organoleptically for colour, taste, aroma and overall acceptability. The mean scores from sensory evaluation showed that the formulated samples were moderately accepted (Fig. 1). There was no significant difference between attributes of the blends. The maximum score for color was obtained by T0 (8.4) and it was decreasing as the pulse ratio was decreasing while the T5, T6 and T7 (8) scored maximum for taste.T7 was at the top on the basis of aroma. With respect to overall acceptability of weaning food, T4 has the maximum score (8) followed by T7 (7.83) and T6 (7.75).

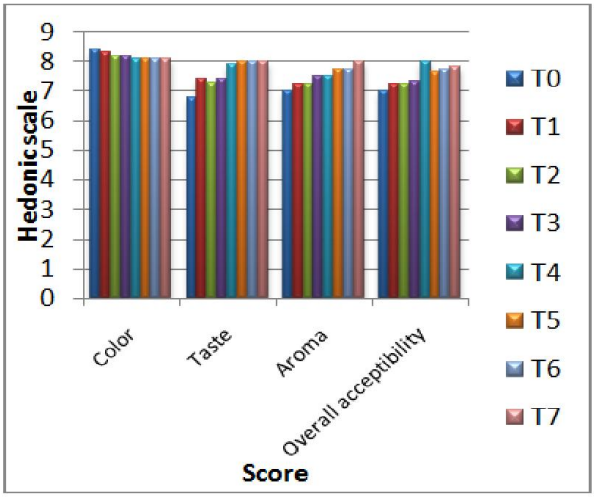

Fig.1. Mean score for the sensory evaluation of weaning food

Shelf life studies: The products were packaged in laminated aluminium foil and stored at ambient temperature for periodic analysis. The ability of the packaging material to prevent moisture and oxygen permeability, withstand impact and protect product from insects and pests attacks were exploited. The shelf life of weaning food was studied at the interval of 15 days till 45days. No significant changes were observed. Similar findings were reported by Ahmed *et al*. (2008) while studying the quality of soya based weaning food.

Microbial counts immediately after packaging indicated that microbes were absent, however, growth were observed on plates on 45th day of storage was 100 – 200 TPC/100g, which was very less. This could be due to contamination during sampling, inoculation or incubation (Fig.2).

The protein content, moisture, ash, fat and Vitamin C of packaged product were measured over 45 days period. A depletion of protein from 24.17% to 20.95% which reduces to 23.92% to 20.62%. This change, however, still meets the recommended protein content for weaning food (Protein Advisory Group, 1972) (Fig.3). Moisture in weaning food initially was ranged from 3.01% to 5.04% which increases upto 3.12% to 5.17%. Nonetheless, the resulting moisture contents of both formulations fall within the moisture content of 3-8% recommended by Oduro *et al*. (2007) (Fig.4). Ash content of weaning food ranged from 4.69 to 3.96 % which reduced to 4.64 to 3.93%. The storage period considerably reduced the ash content of weaning food probably due to increase in moisture content with increase in storage period. The packaging material had no significant effect on ash content (Fig.5).

Table 2. Proximate composition of prepared weaning food

Samples	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Energy (Kcal/100g)	Vit. C (mg/100g)
T0	3.01	4.69	2.47	24.17	65.66	381.55	20.75
T1	3.44	4.62	2.34	23.82	65.78	379.46	24.90
T2	3.87	4.55	2.29	23.32	65.59	376.25	29.05
T3	4.23	4.42	2.21	22.95	66.19	376.45	33.20
T4	4.25	4.28	2.10	22.51	67.24	377.90	37.35
T5	4.40	4.15	1.96	21.98	66.87	373.04	41.50
T6	4.70	4.09	1.82	21.62	67.77	373.94	45.65
T7	5.04	3.96	1.75	20.95	68.94	375.31	49.80

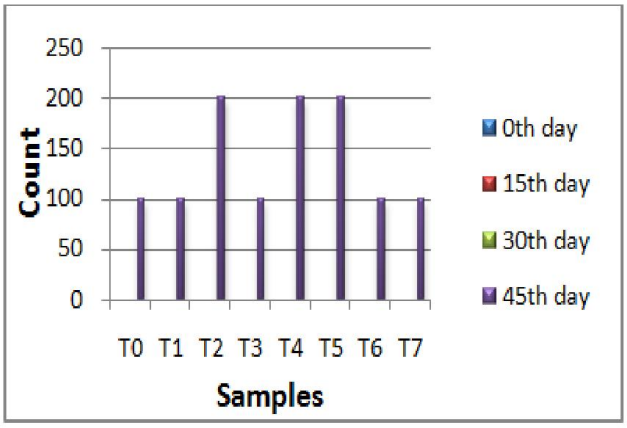

Fig.2. Total Plate Count (per 100g) of weaning food packed in laminated aluminium foil

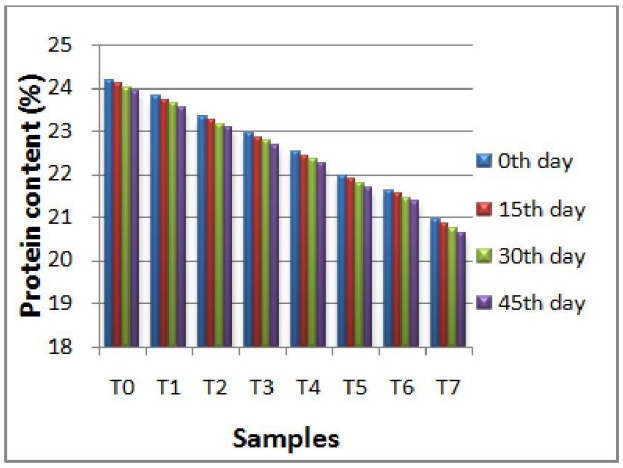

Fig.3. Protein content (%) of weaning food packed in Laminated aluminium foil

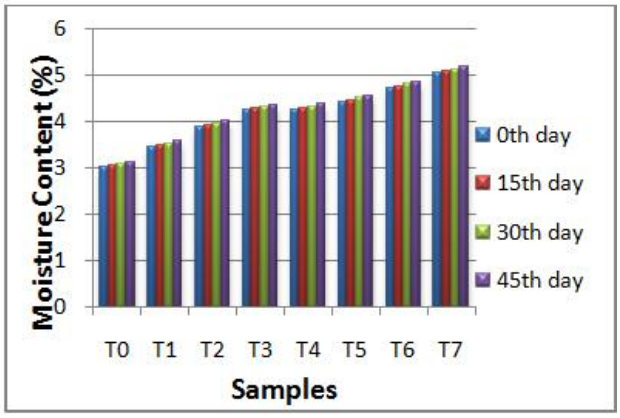

Fig.4. Moisture content (%) of weaning food packed in Laminated aluminium foil

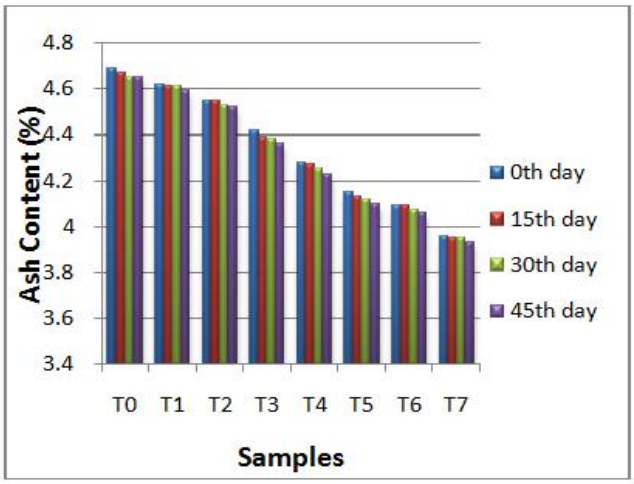

Fig.5. Ash content (%) of weaning food packed in laminated aluminium foil

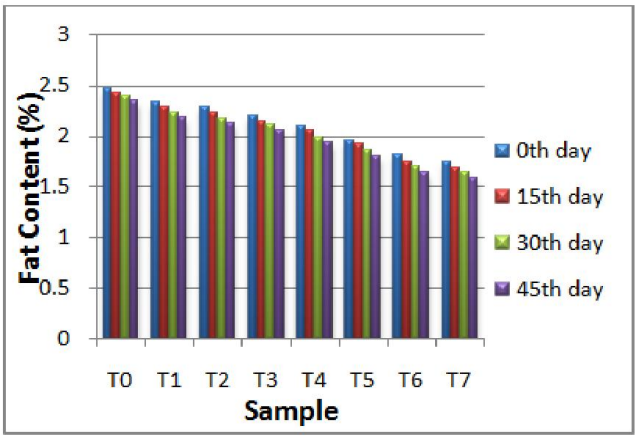

Fig.6. Fat content (%) of weaning food packed in Laminated aluminium foil

(Fat content of weaning food ranged from 2.47 to 1.75 %. On critical evaluation of result it was found that fat content of weaning food was considerably reduced as the proportion of pineapple pomace is incorporated (Fig.6). Vit. C content of weaning food ranged from 49.8 to 20.75 mg/100g which on storage reduced to 47.31 to 18.26 mg/100g (Fig.7)).

There was no significant difference in the moisture, ash, fat, protein and Vit.C contents before and after the 45 days evaluation period. This implies that all the formulation has the same shelf life and all can be stable after 45 days of formulation. The packaging material was able to protect the products from insect attacks that could have introduced pathogenic organisms to the stored food. The products will have longer shelf life if stored at low temperatures, due to slow air movement and low moisture diffusion coefficient. Sufficient time must be given to the study of product characteristics in order to establish true product life span.

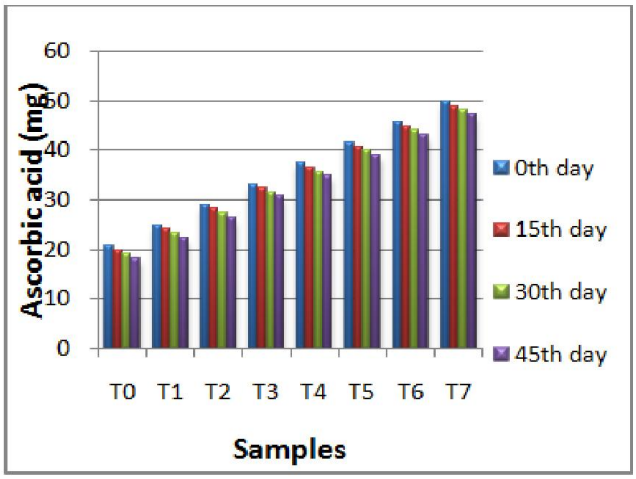

Fig.7. Vit.C content (mg/100g) of weaning food pac ked in Laminated aluminium foil

Conclusion

The utilization of pulse and pineapple pomace flour along with banana flour increases the nutritional value of weaning food. On critical evaluation of the result during storage, it was found that the ash, protein, fat, and ascorbic acid content of weaning food packed in laminated aluminium foil, decreased with increase in storage period. From all the preparations, it was seen that the weaning food with 50% pulse flour, 30% banana flour and 20% pineapple pomace flour (Sample T4) was accepted by panel judges depending on sensory evaluation and was best according to nutritional value having moisture 3.87%, ash 4.28%, fat 2.1%, protein 22.51% and Vit.C 37.35 mg/100g. On the basis of above results revealed in the present study it might be concluded that this formulation of weaning food was possible to satisfy consumer taste and preferences and will be accepted in the market.

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