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Studies on Effect of HDPE and LDPE on Storage Stability of Weaning Food prepared from Pulse, Banana and Pineapple Pomace

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ABSTRACT: The present study was conducted on development, quality evaluation and storage stability of 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 HDPE and LDPE 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.

KEYWORDS: Waste Utilization, weaning food, pulse, banana and pineapple pomace powder, nutritional density, HDPE and LDPE.

INTRODUCTION

There is no clear definition of weaning food but in general it include all staple food that are the first food added to the diet of infants. At high moisture the product turns bitter owing the hydrolytic rancidity. They are mostly available in bag- in-box type packaging where HDPE and LDPE is used as sealant layer. (Mishra *et al*., 2013)

Packaging systems are designed for maintaining the benefits of food processing after the process is complete, enabling foods to travel safely for long distances from their point of origin and still be wholesome at the time of consumption (Marsh & Bugusu, 2007). From an environmental perspective, they affect, more or less significantly, the life cycle of a food because of the impacts linked to their production, transportation and disposal (Andersson & Ohlsson, 1999; Andersson, Ohlsson, & Olsson, 1998; Banar & Çokaygil, 2009; Deckers,Meinders, Meuffels, Ram, & Stevels, 2000; Humbert, Rossi, Margni, Jolliet, & Loerincik, 2009; Keoleian, Phipps, Dritz, & Brachfeld, 2004). For this reason, a package design must be carried out considering the issues not only of cost, shelf-life, safety and practicality, but also of environmental sustainability (Leceta et al., 2013; Zampori & Dotelli, 2014).

According to Meneses, Pasqualino, and Catells (2012), food products today are offered to consumers in a wide range of packaging alternatives in terms of materials used, forms and sizes. There are a number of important factors to be considered in the food packaging field, such as food quality and freshness conservation, a pleasant image, good marketing appeal, correct product identification, storage and distribution convenience (Meneses et al., 2012; Williams & Wilkström; 2011).

Polyethylene is the most widely used plastic in food packaging and has the simplest structure based on –CH2– units (Robertson, 2012). Polyethylene can be branched or linear, like low-density polyethylene (LDPE) and high-density polyethylene (HDPE), respectively. Both materials have different crystallinities. LDPE has a structure with many branched chains that interrupt the regular arrangement of the atoms, generating a low degree of crystallinity (50–70%) and introducing amorphous zones. HDPE has a linear and ordered structure with few short-chain branches, favoring a parallel chain configuration, a higher degree of crystallinity (90%) and fewer amorphous zones (Colı´n-Cha´vez et al., 2013).

The widespread problem of infant malnutrition in the developing world has stirred efforts in research, development and extension by both local and international organizations. As a result, the formulation and development of nutritious weaning foods from local and readily available raw materials have received a lot of attention in many developing countries. Malnutrition is a major health problem in developing countries and contributes to infant mortality, poor physical and intellectual development of infants, as well as lowered resistance to disease and consequently stifles development. 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 growing 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. Generally, foods eaten in developing countries contain high levels of carbohydrate with very low or no proteins due to the high cost of protein rich foods and some traditional beliefs about feeding infants with protein foods.

In light of above discussion, a study on the development of weaning food was undertaken with the following objective- 1) To develop pulse, banana and pineapple pomace based weaning food. 2) To evaluate the nutritional, physico-chemical and microbiological characteristic of the prepared weaning food. 3) To evaluate sensory characteristic of weaning food. 4) To evaluate the storage stability of weaning food under HDPE and LDPE.

Material and Methods

The raw materials required for the preparation of baby foods were procured from the local market of Allahabad 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:

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

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:

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.

RESULT AND DISCUSSIONS

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 eight different samples of weaning food were packed in HDPE and LDPE. 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%. The protein content was decreasing with the decrease in the ratio of pulse flour. 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). Kadwe *et al.,* 1974 reported the protein content of 25 varieties of pulses ranges from (19.9) to (27.2) percent.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. Vitamin C content of weaning food was increasing with the increase in pineapple pomace incorporation.

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

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). Mishra *et al* (2014) reported similar results when weaning food was packed in Aluminium foil.

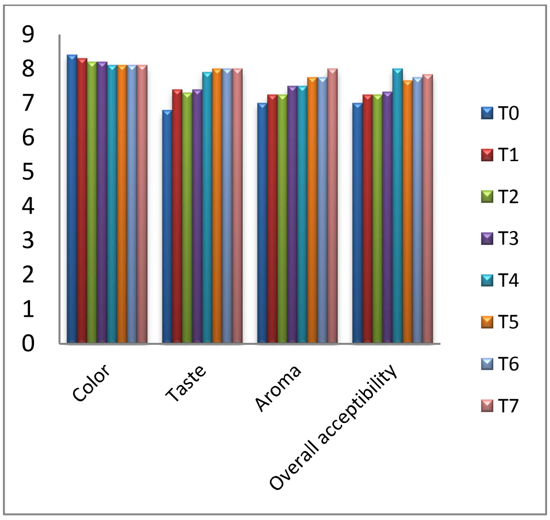

Fig.1. Mean score for the sensory evaluation of weaning food.

Shelf life studies: The products were packaged in HDPE and LDPE 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.

The overall bacteriological status of the prepared weaning food was observed to be satisfactory. Microbial counts immediately after packaging indicated that microbes were absent, however, growth were observed on plates from 30th day of storage which was 100 – 200 TPC/100g and increased upto 500 TPC/ 100g on 45th day when packed in HDPE and was 100 – 400 TPC/100g and increased upto 800 TPC/100g when packed in LDPE, which was very less. This could be due to contamination during sampling, inoculation or incubation (Fig.2 and 3). On critical evaluation of results, it was found that the weaning foods were free from yeast and mold, till 45 days of storage in both the packaging materials (HDPE and LDPE). It reveals that weaning foods were free from contaminated water. The low count of the examined food indicated adequate thermal processing, good quality of raw material and as a result of good different processing conditions under which production was carried out.

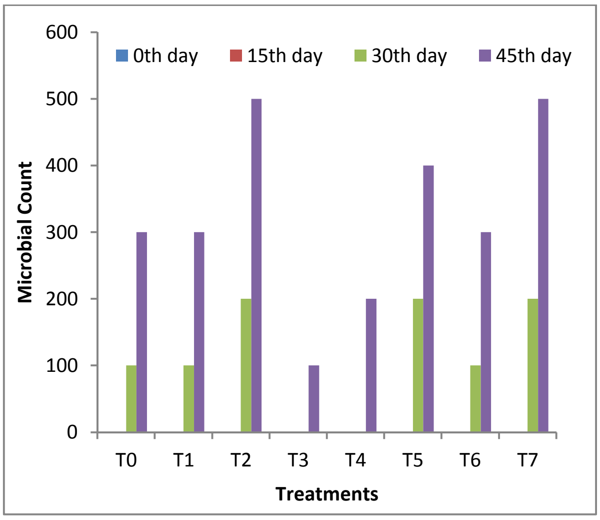

Fig.2. Total Plate Count (per 100g) of weaning food packed in HDPE

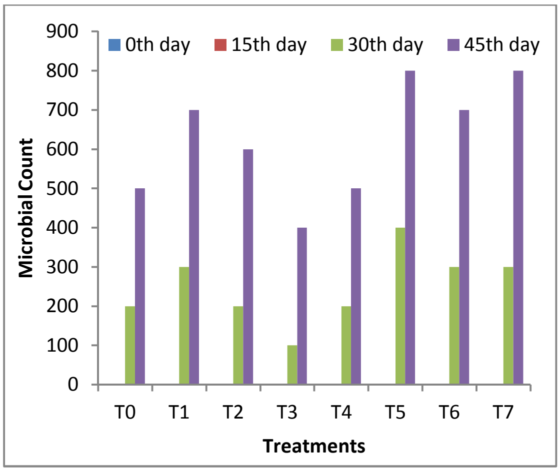

Fig.3. Total Plate Count (per 100g) of weaning food packed in LDPE

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 23.78% to 20.54% when packed in HDPE whereas reduced to 23.62% to 20.44% in LDPE packaging. This change, however, still meets the recommended protein content for weaning food (Protein Advisory Group, 1972) (Fig.4 and 5). Moisture in weaning food initially was ranged from 3.01% to 5.04% which increases upto 3.21% to 5.22% in HDPE packaging whereas upto 3.32% to 5.41% when packed in LDPE. Nonetheless, the resulting moisture contents of all the formulations fall within the moisture content of 3-8% recommended by Oduro *et al*. (2007) (Fig.6 and 7). Ash content of weaning food ranged from 4.69 to 3.96 % which reduced to 4.61 to 3.89% in HDPE packaging and to 4.58 to 3.84% in LDPE packaging system. 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.8 and 9). Fat content of weaning food ranged from 2.47 to 1.75 % and reduced to 2.32 to 1.47% in HDPE and to 2.18 to 1.35% in LDPE packed food. 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.10 and 11). 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 in both the packaging material (Fig.12).

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.

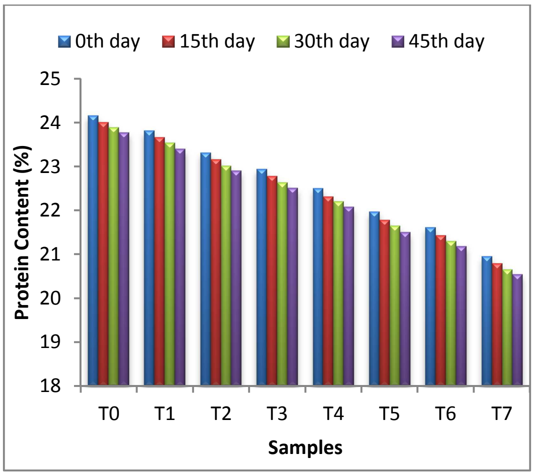

Fig.4. Protein content (%) of weaning food packed in HDPE

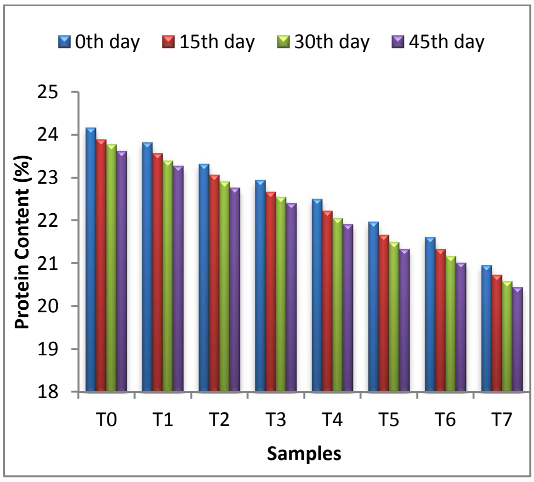

Fig.5. Protein content (%) of weaning food packed in LDPE

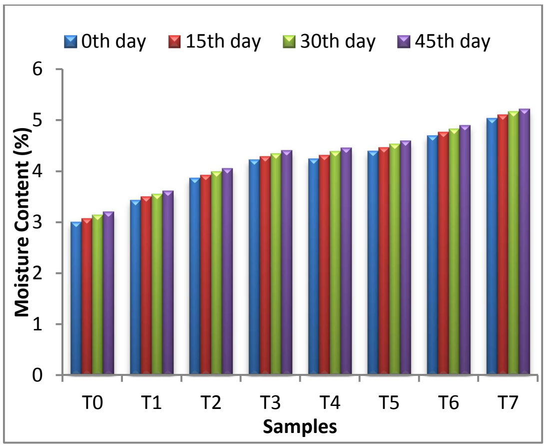

Fig.6. Moisture content (%) of weaning food packed in HDPE

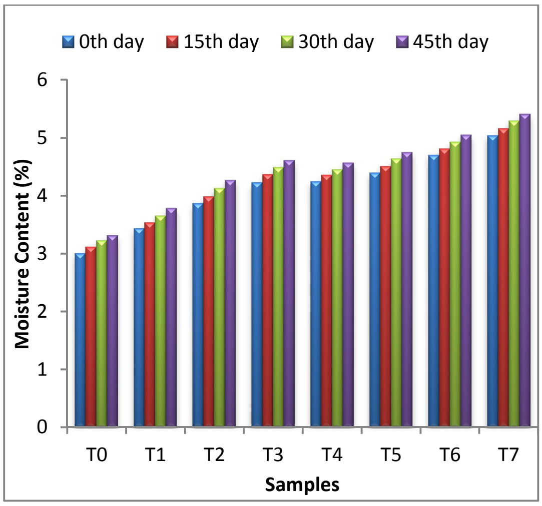

Fig.7. Moisture content (%) of weaning food packed in LDPE

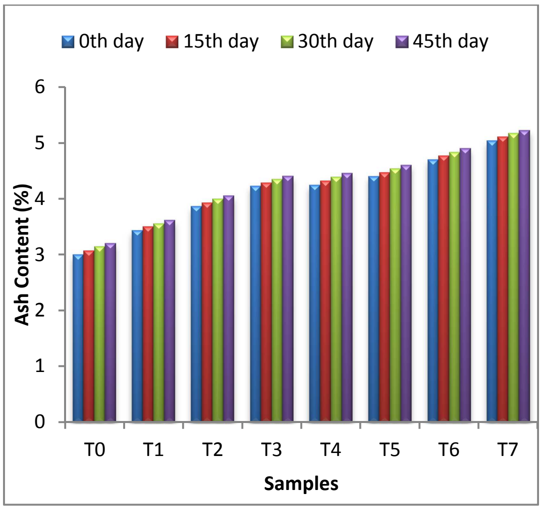

Fig.8. Ash content (%) of weaning food packed in HDPE

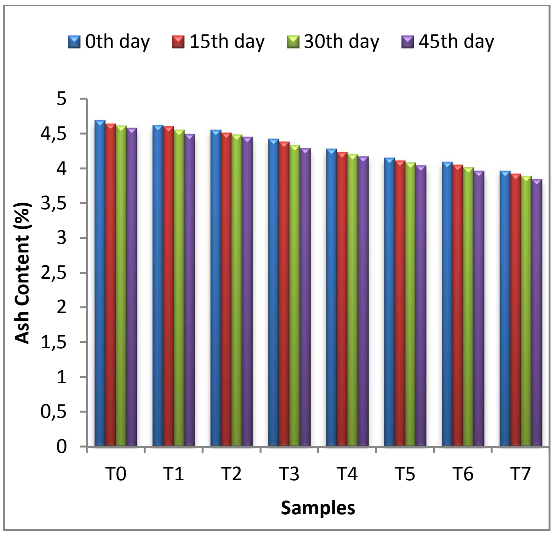

Fig.9. Ash content (%) of weaning food packed in LDPE

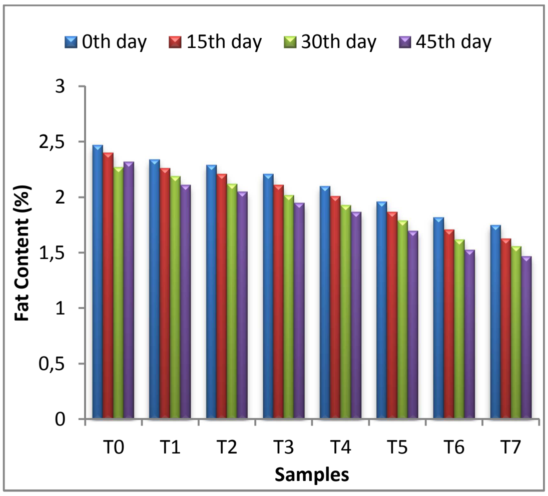

Fig.10. Fat content (%) of weaning food packed in HDPE

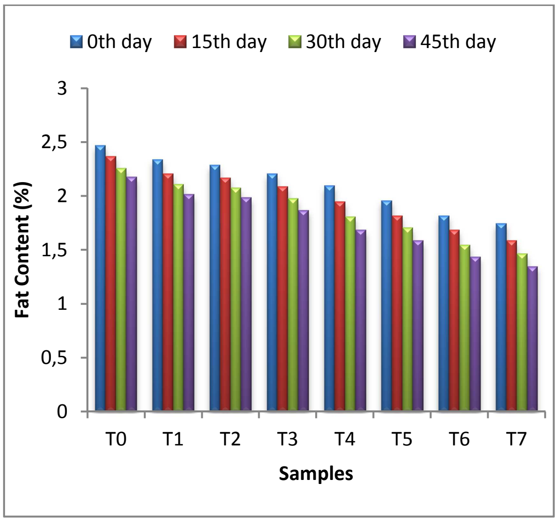

Fig.11. Fat content (%) of weaning food packed in LDPE

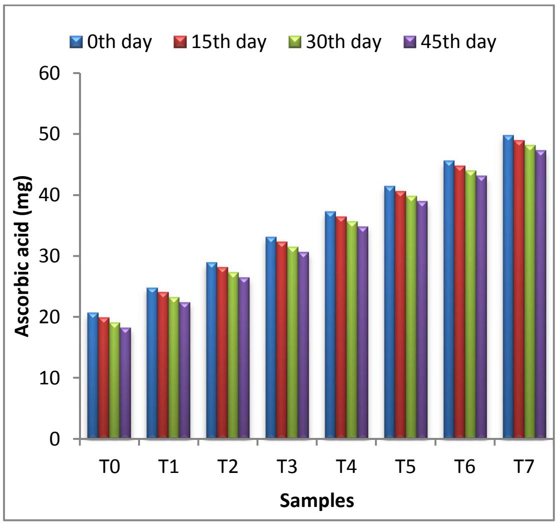

Fig.12. Vit.C content (mg/100g) of weaning food packed in HDPE and LDPE

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 HDPE and LDPE, 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. HDPE is a better packaging material in comparision to LDPE as the nutrient loss was insignificant in weaning food packed in HDPE.

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