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Studies on effect of different packaging materials on shelf life of mix fruit bar

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Abstract
Fruit bar is one of the intermediate moisture food product which having good shelf life over long period. Despite increase in storage period of fruit bar with different packaging materials leads to some physical and chemical changes, some are beneficial as well as detrimental. Hence there is need of study the effect different packaging materials on fruit bar over long storage periods. So present investigation is carried out determine the effect of different packaging materials on fruit bar over different storage period (60 days) by using various packaging materials like HDPE, LDPE, Aluminum foil and PET with regular interval of 15 days. Finally it was found that Aluminum foil and PET were having good effect over LDPE and HDPE.

Keywords: fruit bar, intermediate moisture food, pet, hdpe and ldpe

1. Introduction
India is the second largest producer of fruits in the world and holds first position in production of fruits like mango, banana, sapota, pomegranate and aonla. India has diversified agro climatic condition and environmental condition for production of a wide range of tropical, subtropical and temperate fruits. As per National Horticulture Database published by National Horticulture Board, during 2013-14, India produced 88.977 million metric tons of fruits and 162.89 million metric tons of vegetables. The area under cultivation of fruits stood at 7.2 million hectares while vegetables were cultivated at 9.39 million hectares. The annual production is estimated to be nearly 46 million tones accounting for about 10% of the world production notifying the share ranging from 12.5% of citrus and 20.5% of mango fruits. India contributes only 1% to the export earnings from agricultural products (NHB, 2014) [3].

Fruit leather is the term used for the products prepared by dehydration of fruit pulp. Dried mango bar or leather, popularly called "Ampapar," is an important confectionary product of commerce in India. Fruit leather can be made from a wide variety of fruits, such as apple, apricot, banana, blackcurrant, cherry, grape, peach, pear, pineapple, fig, mango, strawberry, papaya, sweet potato, sapota and jackfruit. The consumer trend nowadays is to seek more natural snack foods made from natural fruits, and fruit leather has all the goodness and nutrients of the fruits in it (Cheman, 1997).

Fruit leathers are dried sheets of fruit pulp that have a soft, rubbery texture and a sweet taste. They are produced by dehydrating of fruit puree into a leathery sheet (Raab and Oehler, 1999) [5]. The edible portion of fruit is pureed, mixed with other ingredients to improve its physicochemical and sensory characteristics, heated, formed (flattened and shaped) and then dried on a flat trays until a cohesive fruit leather is obtained (Phimpharian *et al*., 2011) [6]. Fruit leathers can be eaten as snack foods or added to a variety of food preparations.

Fruit leathers can be dried using various drying processes including sun drying, oven drying, cabinet drying and dehydrator drying (Irwandi *et al*., 1998, Raab and Oehler, 1999) [7, 5]. The composition of the final fruit product may vary depending on the processing conditions. Sun drying has traditionally been the process employed for preparing fruit leather from ripe fruit. However, sun-dried products can become discolored and the process can be unhygienic and lengthy (Teshome, 2010) [8]. Hot air drying is an alternative method that needs less drying time and improves the quality of the dried fruit (Maskan *et al*., 2002 and Garau *et al*., 2007) [9, 10] however it has been shown that hot air drying can promote a decrease in the antioxidant capacity of fruit (such as oranges).

The preservation of fruit leathers depends on their low moisture content (15 - 25%), the natural acidity of the fruit is less and it's high sugar content. Major quality parameters associated with dried fruit products and within no particular order, are change of color / visual appeal, flavor, shape, texture, shelf life, microbial load, retention of nutrients, porosity or bulk density, rehydration properties, water activity, chemical stability and contaminants. These qualities of dried food products are dependent on the raw materials, composition of the food, processing method, environment, packaging and storage conditions (Perera, 2005).

Most fresh fruits have a short harvest season and are sensitive to deterioration and even when stored under refrigerated conditions; therefore, making fruit leather from fresh fruits is an effective way to preserve fruits (Maskan *et al*., 2002) [9].

Hence the present project is under taken to prepare the fruit bar with selected fruits and to promote good nutrition among the consumers. The mix fruit bar has good potential both in domestic and export markets and there is great scope to earn foreign exchange. This technology not only improves the nutrient intake of consumers but also helps the women to start a small scale production unit at home level to supplement their incomes by enabling self-employment in rural sector. This type of value addition by different nutritional fruit certainly helps in income generation of the entrepreneurs at large and promotes good nutrition. (Sarojini *et al*., 2009) [12].

2. Materials and Methods

2.1 Raw materials

The present investigation was carried out at department of food science and technology at vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani Basic raw materials required for research were procured from local market of Parbhani like mango, fig, papaya sugar, pectin Skim milk powder, HDPE, LDPE Aluminum foil and PET.

2.2 Chemicals and Glasswares

The chemicals and glasswares used during the present investigation was taken from the Department of Food Chemistry and Nutrition, College of Food Technology, Parbhani.

2.3 Equipments and Machineries

Equipments including weighing balalce, juicer, hot air oven, muffle furnace and vernier caliper were taken from the Department of Food Chemistry and Nutrition, College of Food Technology, Parbhani.

2.4 Methods

2.4.1 Physical Properties of Fruits

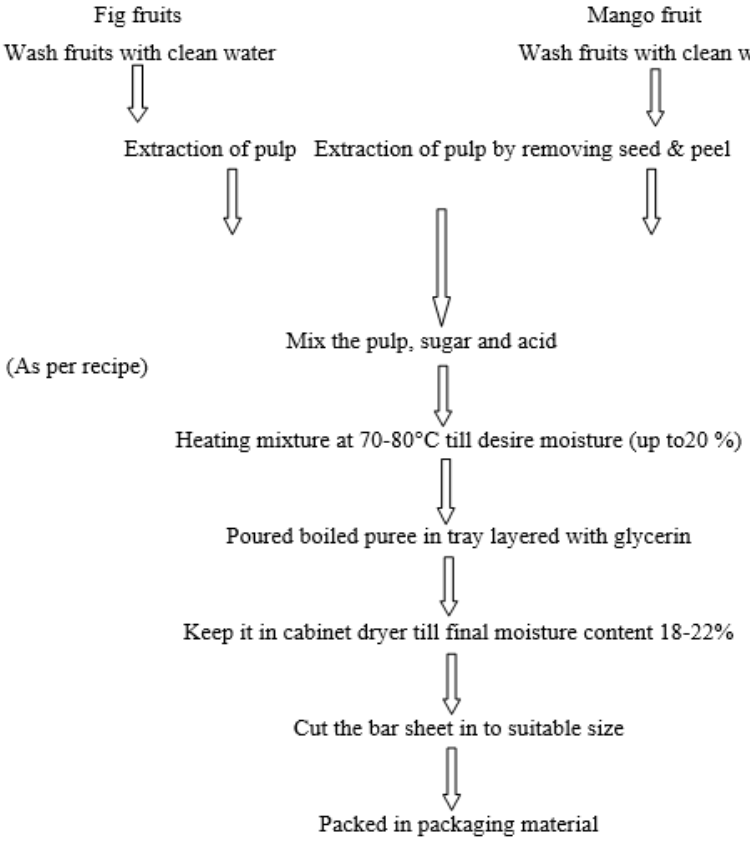
Different physical properties viz., size, shape, colour, diameter, length, percent waste, percent yield and percent seed weight were assessed as per the method give by Polat *et al.,* (2008) [13] and Mikdat (2010) [14].

2.4.2 Chemical composition of fruits

Chemical properties like moisture, fat, protein, carbohydrates, crude fiber, ash and ascorbic acid were analyzed as per the method given by A.O.A.C. (2000) [2] pH, TSS, Titratable acidity, Reducing sugar and Non reducing sugar determine by Ranganna (1995) [15].

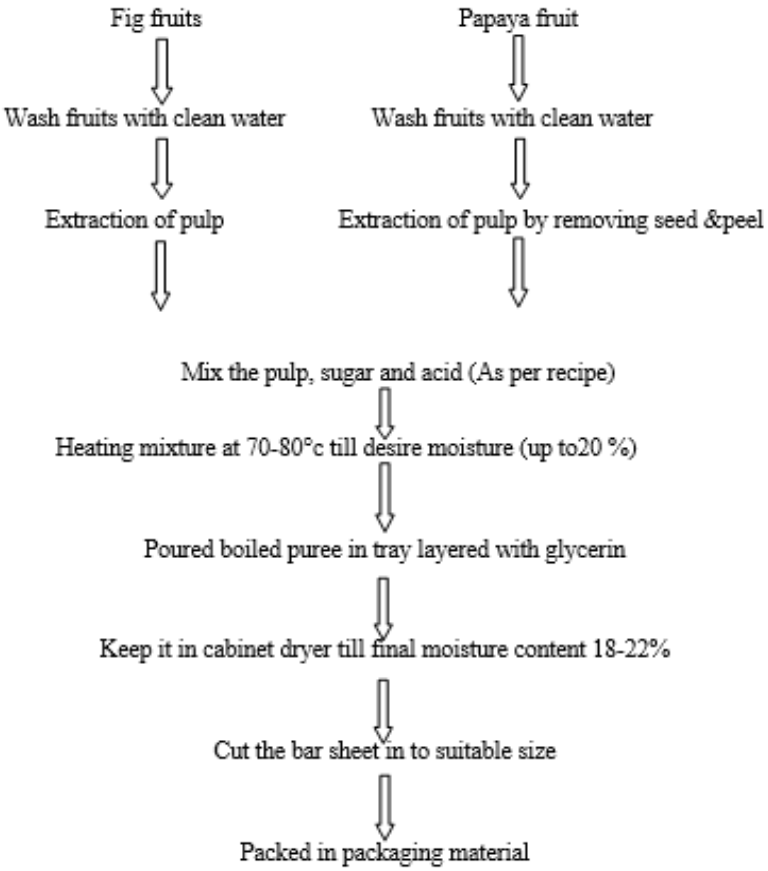
Table 1: Standard recipe for formulation of Fig Mango and Fig Papaya -mix fruit bar

Sr. No.	Ingredients	Quantity					Thickness (cm)
		I	II	III	IV	V	
1	Fig : Mango pulp (gm)	10 : 90	20 :80	30 :70	40 :60	50:50	1.5
2	Fig : Papaya pulp (gm)	10 : 90	20 :80	30 :70	40 :60	50:50	
3	Sugar (°Bx)	32	32	32	32	32	
4	Acid (%) citric acid	1	1	1	1	1	



Flow sheet 1: Preparation of Fig-Mango mix fruit bar

Flow sheet for preparation of Fig-Papaya mix fruit bar



Flow sheet 2: Preparation of Fig-Papaya mix fruit bar

3. Results and Discussion

3.1 Physical properties of fruits

Table 1 showed that the external skin color of fig fruit as dark red, whereas the flesh was found to be dark pink.).The average weight was recorded 26.44 g. The average length and diameter of fruit was found to be 3.7 and 4.1 cm respectively. The per cent waste of fig fruits was recorded 2. The above observations recorded with respect to all the physico-morphological parameters were in close agreement with those reported by Waskar *et al.*, (2003) [16].

Table 1: Physical characteristics of fresh fig, papaya and mango fruits

Sr. No.	Parameters	Fruits		
		Fig	Mango	Papaya
1.	Color	Dark red	Yellowish	Yellowish
2.	Fruit weight(gm)	26.44	211.12	815.7
3.	Diameter(cm)	4.1	6.25	9.20
4.	Length(cm)	3.7	8.6	22
5.	Pulp weight(gm)	98	140.12	632
6	Pulp (%)	98	66.1	78.1
7	Seed weight(gm)	-	37.70	13.90
8	Seed (%)	-	18	1.80
9	Peel weight (gm)	-	34.21	167.2
10	Peel (%)	-	15.9	20.15

*Each value is the average of three determinations

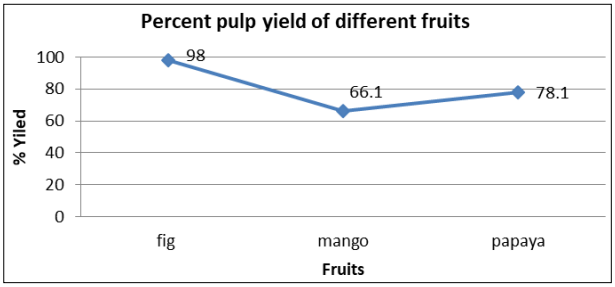


Fig 1

In case of mango, the external skin color of mango fruit was found yellowish, whereas the flesh was found to be dark yellow. The average weight was recorded 211.12gm. The yield of mango pulp found 66.1 percent. The average length was 8.6cm. The weight and percent peel were found to be 34.21gm and 15.9 respectively. The stone per cent was 18 and stone weight was 37.70 gm. The diameter of mango fruit was 6.25cm. The above observations recorded with respect to all the physico-morphological parameters of mango are in close agreement with those reported by Kumar *et al.*, (2006) [17] and Siddiki *et al.*, (2004).

Regarding papaya external or skin color was found yellowish, whereas the flesh found to be reddish yellow. The average weight was recorded 815.7 g. The yield of

papaya pulp was 78.1 percent. The average length and diameter were found to be 22 and 9.20 cm respectively. The weight and percent peel were found to be 166.90 and 20.60 g respectively. The seed per cent was 1.80 and seed weight was 13.90 g. The physico-chemical observations recorded with respect to papaya are in close agreement with those reported by Zaman *et al.*, (2006) [19].

3.2Chemical properties of fresh fruits

Chemical characteristics of fresh fig (*Ficus carica* L.), mango (*Mangifera indica*) and papaya (*Carica papaya*) fruits are given in table 2.

Table 2: Chemical characteristics of fresh Fig, Mango and Papaya fruits

Sr. No.	Constituents	Fruits		
		Fig	Mango	Papaya
1	Moisture (%)	86	82.7	88.8
2	Protein (%)	2.2	0.7	0.86
3	Fat (%)	0.3	0.6	0.35
4	Total carbohydrate (%)	10.5	14.7	8.64
5	Ash (%)	0.5	0.5	0.55
6	Fiber (%)	0.5	0.8	0.8
7	Reducing sugar (%)	9.36	12.3	5.78
8	T.S.S.(0Bx)	18	21	12
9	Titrable acidity (%)	0.2	0.6	0.5
10	pH	5.2	4.3	4.2
11	Ascorbic acid (mg/100g)	12.29	18.6	40.5

*Each value is a mean of three determinations

The table 2 revealed the chemical composition of all 3 fruits used for preparation of fruit bite or bar. The moisture content was as higher in papaya fruit (88.8 %) and lower in mango fruit (82.7%). The fig was rich in protein content (2.2%) as compared to mango and papaya. Fat content was almost same ranging from 0.3 to 0.6 % in all the three fruits used. Large variation was found in total carbohydrates among the three fruits used (8.64–15%). Large variation was also found in total soluble solids of the fruits. Ascorbic acid was highest in papaya fruit (40.5 mg/100gm) as compared to fig fruit (12.29 mg/100 gm) and mango fruit (18.6mg/100 gm). The TSS of mango pulp was higher (21^0Bx) and lower in papaya pulp (12^0Bx). The acidity of fig pulp less (0.2 percent) than mango (0.6) and papaya (0.5 percent).

Due to variation in initial chemical characteristics of fruits the final level of sugar and acid was adjusted by taking into consideration of the initial value of sugar and acid in the product. The initial variation and chemical composition of fruits may effect on drying characteristics and textural characteristics of final product.

The results of chemical composition are in close agreement with the findings of Khapare *et al*., (2010), Othman *et al*., (2009) [21], Siddique *et al*., (2004) [18], Zaman *et al*., (2006) [19] and Zuhair *et al*., (2013) [22].

3.3 Storage stability of bars under different packaging materials

The study was carried on storage of mix fruit barin various packaging material for 60 days. The various packaging material used were LDPE, HDPE, aluminum foil pouch and PET jar at ambient temperature and product was regularly evaluated at 15 days interval. The results are presented in table 3 to 6.

Table 3: Effects of packaging material on shelf life of mix fruit bar (Aluminum file pouch)

Parameter	Days	Sample		Mean	SE	CD
		$F_{30}M_{70}$	$F_{20}P_{80}$			
Color	0	8.5	8.0	8.25	0.014	0.043
	20	8.0	7.5	7.75	0.043	0.130
	40	8.0	7.5	7.75	0.036	0.109
	60	7.5	7.0	7.25	0.028	0.086
Flavor	0	8.0	7.5	7.75	0.043	0.130
	20	8.0	7.5	7.75	0.057	0.173
	40	7.5	7.0	7.25	0.072	0.217
	60	7.0	6.5	6.75	0.028	0.086
Taste	0	8.0	8.0	8.0	0.057	0.173
	20	8.0	7.5	7.75	0.028	0.086
	40	7.5	7.5	7.5	0.050	0.152
	60	7.5	7.0	7.25	0.044	0.132
Texture	0	8.5	8.0	8.25	0.014	0.043
	20	8.5	8.0	8.25	0.01443	0.043
	40	8.5	8.0	8.25	0.014	0.04345
	60	7.0	7.0	7.0	0.028	0.086
Overall acceptability	0	8.0	7.5	7.75	0.05774	0.173
	20	7.5	6.5	7.0	0.028	0.0869
	40	7.5	7.5	7.5	0.050	0.152

Table 4: Effect of packaging material on shelf life of mix fruit bar (PET jar)

Parameter	Days	Sample		Mean	SE	CD
		$F_{30}M_{70}$	$F_{20}P_{80}$			
Color	0	8.5	8.0	8.25	0.014	0.043
	20	8.0	7.5	7.75	0.043	0.130
	40	8.0	7.5	7.75	0.036	0.109
	60	7.5	7.0	7.25	0.028	0.086
Flavor	0	8.0	7.5	7.75	0.043	0.130
	20	8.0	7.5	7.75	0.057	0.173

	40	7.5	7.0	7.25	0.072	0.217
	60	7.0	6.5	6.75	0.028	0.086
Taste	0	8.0	8.0	8.0	0.057	0.173
	20	8.0	7.5	7.75	0.028	0.086
	40	7.5	7.5	7.5	0.050	0.152
	60	7.5	7.0	7.25	0.044	0.132
Texture	0	8.5	8.0	8.25	0.014	0.043
	20	8.5	8.0	8.25	0.01443	0.043
	40	8.5	8.0	8.25	0.014	0.04345
	60	7.0	7.0	7.0	0.028	0.086
Overall acceptability	0	8.0	7.5	7.75	0.05774	0.173
	20	7.5	6.5	7.0	0.028	0.0869
	40	7.5	7.5	7.5	0.050	0.152

Table 5: Effect of packaging material on shelf life of mix fruit bar (HDPE)

Parameter	Days	Sample		Mean	SE	CD
		$F_{30}M_{70}$	$F_{20}P_{80}$			
Color	0	8.5	8.0	8.25	0.014	0.043
	20	8.0	7.5	7.75	0.043	0.130
	40	8.0	7.5	7.75	0.036	0.109
	60	7.5	7.0	7.25	0.028	0.086
Flavor	0	8.0	7.5	7.75	0.043	0.130
	20	8.0	7.5	7.75	0.057	0.173
	40	7.5	7.0	7.25	0.072	0.217
	60	7.0	6.5	6.75	0.028	0.086
Taste	0	8.0	8.0	8.0	0.057	0.173
	20	8.0	7.5	7.75	0.028	0.086
	40	7.5	7.5	7.5	0.050	0.152
	60	7.5	7.0	7.25	0.044	0.132
Texture	0	8.5	8.0	8.25	0.014	0.043
	20	8.5	8.0	8.25	0.01443	0.043
	40	8.5	8.0	8.25	0.014	0.04345
	60	7.0	7.0	7.0	0.028	0.086
Overall acceptability	0	8.0	7.5	7.75	0.05774	0.173
	20	7.5	6.5	7.0	0.028	0.0869
	40	7.5	7.5	7.5	0.050	0.152

Table 6: Effect of packaging material on shelf life of mix fruit bar (LDPE)

Parameter	Days	Sample		Mean	SE	CD
		$F_{30}M_{70}$	$F_{20}P_{80}$			
Color	0	8.0	8.0	8.0	0.057	0.173
	20	8.0	8.0	8.0	0.057	0.173
	40	7.5	7.5	7.5	0.050	0.152
	60	7.0	7.0	7.0	0.028	0.086
Flavor	0	8.0	7.5	7.75	0.057	0.173
	20	7.5	7.5	7.5	0.050	0.152
	40	7.5	7.5	7.5	0.050	0.152
	60	7.0	6.5	6.75	0.028	0.086
Taste	0	8.0	7.5	7.75	0.057	0.173
	20	7.5	7.0	7.25	0.044	0.132
	40	7.5	7.0	7.25	0.044	0.132
	60	7.0	7.0	7.0	0.028	0.086
Texture	0	8.5	8.0	8.25	0.014	0.043
	20	8.0	7.5	7.75	0.057	0.173
	40	7.5	7.0	7.25	0.044	0.132
	60	7.5	7.0	7.25	0.044	0.132
Overall acceptability	0	7.5	7.5	7.5	0.050	0.152
	20	7.5	7.0	7.25	0.044	0.132
	40	7.5	7.0	7.25	0.044	0.132
	60	8.0	7.5	7.75	0.057	0.173

Parameter	Days	Sample		Mean	SE	CD
		$F_{30}M_{70}$	$F_{20}P_{80}$			
Color	0	8.0	8.0	8.0	0.057	0.173
	20	8.0	7.5	7.75	0.057	0.173
	40	7.5	7.0	7.25	0.044	0.132
	60	7.0	7.0	7.0	0.028	0.086

Flavor	0	8.5	8.0	8.25	0.014	0.043
	20	8.0	7.5	7.75	0.057	0.173
	40	7.5	7.0	7.25	0.044	0.132
	60	7.0	6.5	6.75	0.028	0.086
Taste	0	8.5	8.5	8.5	0.028	0.086
	20	8.0	8.0	8.0	0.057	0.173
	40	7.5	7.0	7.25	0.044	0.132
	60	7.0	7.0	7.0	0.028	0.086
Texture	0	8.0	8.0	8.0	0.057	0.173
	20	8.0	7.5	7.75	0.057	0.173
	40	7.5	7.0	7.25	0.044	0.132
	60	7.0	6.5	6.75	0.028	0.086
Overall acceptability	0	8.0	7.5	7.75	0.057	0.173
	20	8.0	7.5	7.75	0.057	0.173
	40	8.0	7.5	7.75	0.057	0.173
	60	8.0	6.5	7.25	0.028	0.086

Plate 1: Effect of Different Packaging Material on Shelf Life of Mix Fruit Leather during Storage Study

Color

It is showed from table7 to 10 that bar packed in LDPE and HDPE bag showed decrease in color during 0 and 60 days of storage compared to aluminum foil pouches and PET jar. The aluminum foil pouches show significant result for color as compared to LDPE and HDPE bag during 60 day storage. The polyethylene bag is having low barrier properties to moisture as compared to aluminum foil pouches and PET jar. Hence LDPE and HDPE packed sample showed more changes in color during 60 days storage as compared to aluminum foil pouches and PET jar.

Flavor

Flavor was significantly affected during storage. The flavor was decreased progressively during storage time as compared to initial day of period. The intensity of flavor changes was more sever in LDPE and HDPE bags as compared to Aluminum foil pouch and PET jar. The aluminum foil pouches and PET jar packed bar exhibited marginal decrease in flavor during 60 days of storage.

Taste

The taste intensity was decreased with storage in all the material used. However, the intensity of taste changes was again more in HDPE and LDPE as compared to aluminum foil pouch and PET jar. It can be observed from result bar sample packed aluminum foil pouch and PET jar exhibited less decrease in taste score during 60 days storage as compared to LDPE and HDPE. Polyethylene packed samples showed significant changes in taste as compared to aluminum foil and PET jar packed samples.

Texture

It is clearly evident from the table that texture of bar decreased progressively during storage in all the packaging material. The textural changes were less in aluminum foil stored packages as compared other packaging material used. The texture of product remained more or less as that of fresh bar in aluminum foil pouches. The texture was severally affected in LDPE and HDPE this might be due to higher water vapor transfer rate of LDPE and HDPE.

Overall acceptability

It is clearly evident from table that overall acceptability of bar decreased progressively during storage in all packaging material. The table showed that bar packed in aluminum foil and PET jar exhibited minimum decrease in overall acceptability during 60 days of storage as compared to LDPE and HDPE. Hence it was decided to pack the bars in aluminum foil pouches for preserving color, flavor, taste and texture of the product. PET jar can also equally use as alternative packaging material to aluminum foil pouches due to its convenience in opening.

The result as storage study are agreement with the finding of Singh *et al.*, (2003) [24] in storage of mango bar in LDPE, wax coated paper and aluminum foil and Manimegalai *et al*., (2001) [23] in processing and preservation of jack fruit bar stored in butter paper, polypropylene, metalized polyester, LDPE, and laminate pouches.

Statistical Analysis

The analysis of variance of the data obtained will be done by using Completely Randomized Design (CRD) for

different treatments as per the methods given by Panse and Sukhatme, (1985) [1]. The analysis of variance revealed at significance of P <0.05 level, S.E. and C.D. at 5 % level is mentioned wherever required.

Conclusion

From the present investigation it has been concluded that quality of fruit bar got decreases as storage period increase due to various physicochemical changes. Although fruit bar is self-stable fruit product however as storage period increases there is decrease in quality of fruit bar. as per packaging materials concerns the better quality was retained by Aluminum foil as well as PET over the LDPE and HDPE. So it should be suggested that use aluminum foil and PET as packaging materials for long storage of fruit bar which leads to retain quality of product.

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