

SHELF LIFE OF COMPOSITE FLOUR IN DIFFERENT PACKAGING MATERIALS UNDER ACCELERATED CONDITION

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Abstract : “Increasing prevalence of obesity and physical inactivity has lead to increase in number of people with diabetes. A composite flour utilizing *ragi* and wheat flour is used to prepare composite flour ratio being 70:30 (Wheat: Finger millet). The composite flour contains fairly good amount protein (10.49%), ash (1.38%) and 251.724 (mg/ 100 g) calcium which shows that the product is nutritionally rich especially in terms of calcium and protein. The fat content (1.5%) is quite low. The storage studies were performed under accelerated condition (89% RH and 40°C temp.) using the packaging materials multilayer, LDPE and kraftpaper. The packed samples of composite flour were analyzed after a fixed interval of 10 days for change in moisture, fat, rancidity and colour up to 90 days. After 90 days of storage it was found that multilayer is best and cost economic packaging material for composite flour.”

Keywords : Accelerated condition, Composite flour, Packaging materials

INTRODUCTION

Rapid urbanization involving changes in occupation patterns, life styles, family structures and value system are reflected as changes in practices and in the level of physical activity. These changes could result in a significant decrease in the overall fiber content of the diet (Popkin *et al.*, 2001) and associated with rising affluence induced by developmental transition contributed to increasing prevalence of overweight/obesity (Sindhi and Jain, 2006).

Coarse cereals can provide viable alternatives to diversify sources of health components in foods. Obviously, the benefits are highest for whole grain cereal consumption (Dykes and Rooney, 2007).

Millet is a cereal crop plant belonging to the grass family, Graminae (FAO, 1972). Millet is one of the most nutritious and high in starch, making it good high-energy foods. Awasthi and Mishra (2004) reported that millet based diet are helpful in lowering the blood glucose levels than wheat or rice diet and also reported that high intake of fiber is associated with a low CHD incidence.

Ragi contains 7.7 per cent protein, 1.5 per cent fat, 2.6 per cent minerals, 3.6 per cent fiber, 72.6 per cent carbohydrate and its 100 g of seeds contains 350 mg of calcium, 283 g of phosphorus, 3.9 mg of iron, 0.19 mg of riboflavin, 1.1 mg of niacin and 0.42 mg of thiamin (Hulse *et al.*, 1980).

A composite flour utilizing *ragi* is prepared. To prepare this wheat flour is fortified with *ragi* flour in the ratio of 70:30 (Wheat: Finger millet). Such a ratio provide the consumer with the benefits of *ragi* flour without much altering their well adapted flavor of wheat flour thus making it suitable for human consumption.

In addition to food design and food quality, the

packaging of the food material is also important. The basic reason behind this is that the shelf life of the food material should be as long as possible and at the same time the packaging material property should be such that there should be no occurrence of any adverse effect i.e. the packaging material should have enough strength so as to withstand the dead load coming on to it even during handling.

In the selection of suitable packaging materials or a particular food, the focus is typically on the barrier properties of the packaging materials. Foods can be classified according to the degree of protection required, such as maximum moisture gain or oxygen uptake. Calculation can then be made to determine whether a particular packaging material would provide the necessary barrier required.

The present study aims to study the storage behavior and find out the most suitable packaging material for composite flour.

MATERIAL AND METHOD

Storage studies

To estimate the Shelf life of composite flour and for selecting the appropriate material for packaging the storage studies under accelerated storage conditions were performed for 90 days. The samples were drawn at the interval of 10 days.

The composite flour was packed into the three selected packaging materials multilayer (metalized low density polyethylene), kraft paper and LDPE (low density polyethylene) available in the local market. The multi-layer packaging material was metalized polyethylene film. All the 3 packaging material were good in quality and had no sign of infections on their inner or outer surface. Different tests were conducted to evaluate the characteristics of packaging materials as thickness, grammage,

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substance weight, bursting strength and Water vapour transmission rate.

The set up for storage study

Saturated solution of Potassium Nitrate was filled in the bottom of the desiccators (230 mm, Marck) and kept in an incubator maintained at 40°C. This way accelerated conditions of storage i.e. 89% of relative humidity and temperature 40°C were maintained in the desiccators (Greenspan, 1977). To keep all the samples under accelerated conditions of storage 9 desiccators were taken. 9 desiccators contained 15 samples; 5 replication of samples of the composite flour were packed in multilayer, LDPE and kraft paper. After putting all the packed samples of

composite flour in respective desiccators, it was closed by the vacuum grease properly. The desiccators which contained 15 packets were numbered as D1, D2, D3, D4, D5, D6, D7, D8 and D9. These desiccators were placed in the incubator maintained at 40°C to achieve 89% of relative humidity. The desiccators which were numbered as D1, D2, D3, D4, D5, D6, D7, D8 and D9 were opened at a fixed time interval of 10 days one-by-one up to 90 days and analyzed for moisture, fat, rancidity and colour using the A.O.A.C. method. The 03 side closed packages size 10cm x 10 cm were prepared from each materials were cut and 20 g of composite flour was packed and heat sealed. The packages were leveled using the scheme given in Table 1.

Table 1: Plan of work

	P1					P2					P3				
	R1	R2	R3	R4	R5	R1	R2	R3	R4	R5	R1	R2	R3	R4	R5
D0	P1R1 D0	P1R2 D0	P1R3 D0	P1R4 D0	P1R5 D0	P2R1 D0	P2R2 D0	P2R3D 0	P2R4 D0	P2R5 D0	P3R1 D0	P3R2 D0	P3R3 D0	P3R4 D0	P3R5 D0
D1	P1R1 D1	P1R2 D1	P1R3 D1	P1R4 D1	P1R5 D1	P2R1 D1	P2R2 D1	P2R3D 1	P2R4 D1	P2R5 D1	P3R1 D1	P3R2 D1	P3R3 D1	P3R4 D1	P3R5 D1
D2	P1R1 D2	P1R2 D2	P1R3 D2	P1R4 D2	P1R5 D2	P2R1 D2	P2R2 D2	P2R3D 2	P2R4 D2	P2R5 D2	P3R1 D2	P3R2 D2	P3R3 D2	P3R4 D2	P3R5 D2
D3	P1R1 D3	P1R2 D3	P1R3 D3	P1R4 D3	P1R5 D3	P2R1 D3	P2R2 D3	P2R3D 3	P2R4 D3	P2R5 D3	P3R1 D3	P3R2 D3	P3R3 D3	P3R4 D3	P3R5 D3
D4	P1R1 D4	P1R2 D4	P1R3 D4	P1R4 D4	P1R5 D4	P2R1 D4	P2R2 D4	P2R3D 4	P2R4 D4	P2R5 D4	P3R1 D4	P3R2 D4	P3R3 D4	P3R4 D4	P3R5 D4
D5	P1R1 D5	P1R2 D5	P1R3 D5	P1R4 D5	P1R5 D5	P2R1 D5	P2R2 D5	P2R3D 5	P2R4 D5	P2R5 D5	P3R1 D5	P3R2 D5	P3R3 D5	P3R4 D5	P3R5 D5
D6	P1R1 D6	P1R2 D6	P1R3 D6	P1R4 D6	P1R5 D6	P2R1 D6	P2R2 D6	P2R3D 6	P2R4 D6	P2R5 D6	P3R1 D6	P3R2 D6	P3R3 D6	P3R4 D6	P3R5 D6
D7	P1R1 D7	P1R2 D7	P1R3 D7	P1R4 D7	P1R5 D7	P2R1D 7	P2R2D 7	P2R3 D7	P2R4 D7	P2R5 D7	P3R1 D7	P3R2 D7	P3R3 D7	P3R4 D7	P3R5 D7
D8	P1R1 D8	P1R2 D8	P1R3 D8	P1R4 D8	P1R5 D8	P2R1D 8	P2R2D 8	P2R3 D8	P2R4 D8	P2R5 D8	P3R1 D8	P3R2 D8	P3R3 D8	P3R4 D8	P3R5 D8
D9	P1R1 D9	P1R2 D9	P1R3 D9	P1R4 D9	P1R5 D9	P2R1D 9	P2R2 D9	P2R3 D9	P2R4 D9	P2R5 D9	P3R1 D9	P3R2 D9	P3R3 D9	P3R4 D9	P3R5 D9

Where,

D0 to D9 = showing days from 0 to 90 with the interval of 10 days.

P1, P2, P3= for the three packaging materials i.e. multilayer, L.D.P.E and kraft paper respectively.

R1 to R5= shows five replication for each packaging material

RESULT AND DISCUSSION

The composite flour was analyzed for the moisture, fat, protein, ash, total carbohydrate and calcium. The results of the analysis are given in the Table 2.

Table 2: Proximate Chemical Composition of the composite flour

S.No.	Constituents	Value (%)
1.	Moisture	8.19
2.	Protein	10.49
3.	Fat	1.50
4.	Ash	1.38
5.	Total carbohydrate	78.44
6.	Calcium (mg/ 100g)	251.724

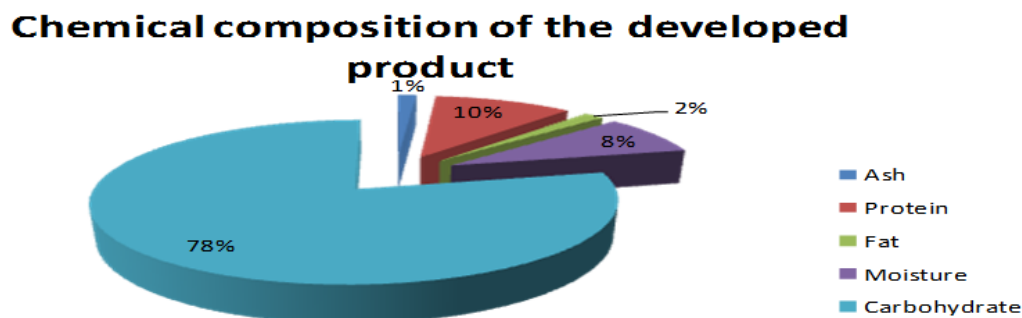


Fig. 1. Proximate composition of Composite Flour

Storage Study of the Composite Flour

The prepared product was packed into three different packaging materials; multilayer (metalized low

density polyethylene), LDPE and kraft paper. The characteristics of the packaging materials were tested and the results of the tests are given in the Table 3:

Table 3 : Characteristics of the packaging materials

S. No.	Packaging Material	Weight (g)	Thickness (μ)	GSM (cm ²)	Bursting Strength(kg/ cm ²)	WVTR (g/m ² at 24 hr 89% RH, 37°C)
1.	Multilayer	1.175	52.0	116.0	9.5	0.60
2.	LDPE	0.801	80.0	41.0	7.0	5.0
3.	Kraftpaper	1.730	56.0	171.0	12.1	15.0

Punjra (1995) discussed about the characteristics of the different packaging materials in detail and found that the WVTR of 25 micron LDPE is 15 and 25 micron metalized polyethylene is ~1 at 90% RH, 37°C environment. The packaging materials which were used in the present work is multi layer which is 52 micron metalized polyethylene, 80 micron LDPE and 56 micron kraft paper and their respective WVTR at 89% RH, 40°C is 0.60, 5.0 and 15.0 g/m².

Change in moisture content

It was found that the product packed in different packaging material started to show significant difference after the end of storage time of 10 days. The moisture content after storage under accelerated condition after 90 days was 11.93%, 13.89% and 17.42% for multilayer, LDPE and kraft paper respectively which was initially 8.19.

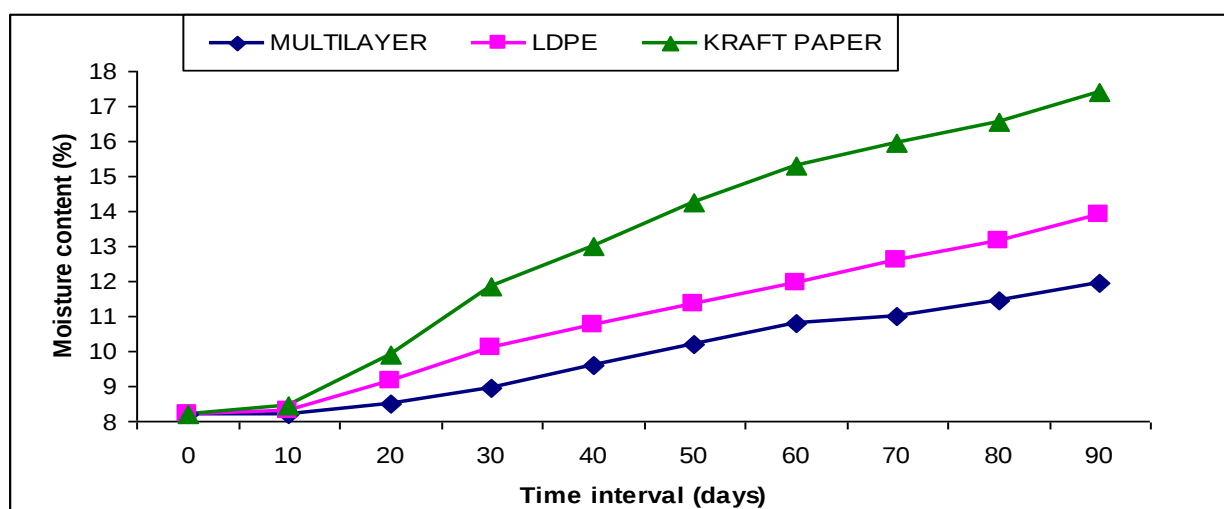


Fig. 2. Moisture content (%) of composite flour under accelerated condition in different packaging materials

It is clearly observed that the the product which was packed in the multilayer; has gained minimum amount of moisture. According to Punjra (1995)

and testing of packaging materials the multi layer have lowest WVTR values than the other materials. Therefore, the gain in moisture content due to expose

of packed product in accelerated conditions will be lower. Since the product was exposed to accelerated conditions; at 89% RH of the environment present inside the desiccators, it is natural that the product will gain moisture. The increase of moisture content of the packed product in different packaging materials is directly proportional to the WVTR of the packaging materials. Butt (2003), reported that packaging materials with high moisture permeability may predispose its content to high rate of deterioration.

Change in fat content

There was a drastic decrease in the fat content of samples under accelerated condition which was 1.5% initially and decreased to 1.29%, 0.998% and 0.545% for multilayer, LDPE, and kraft paper respectively after 90 days. This occurred due to variation in packaging materials.

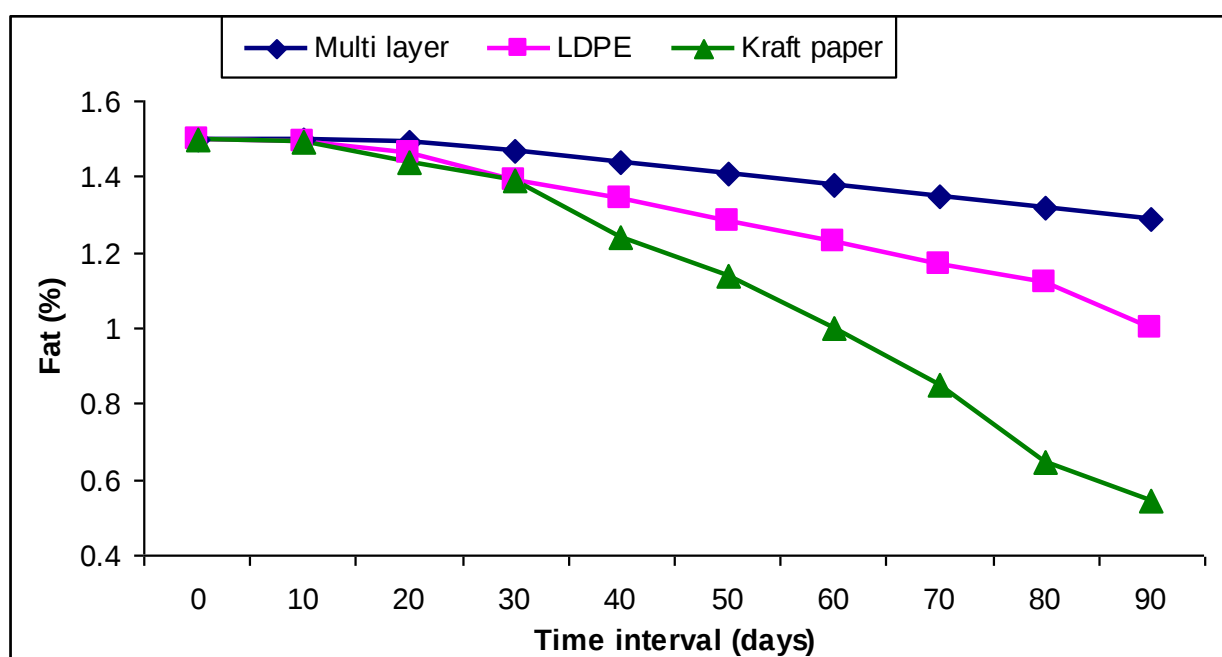


Fig. 3. Fat content (%w/w) of the product during storage under accelerated Condition

The decrease in the fat into free acid might be due to the activation of lipase/lipoxygenase which splits up fat into free acid and glycerol in the presence of moisture and heat. Leelavathi and Haridas (1984) demonstrated that fat deterioration was at faster rate in the flour containing 12% moisture than flour containing lower moisture. Many other factors as light, high temperature and addition of fortifications could also cause fat spoilage.

Change in rancidity

Rancidity is an important parameter in terms of the evaluation of the product quality. It is expressed in terms of peroxide value. The peroxide value of the composite flour increased from 0.533 to 1.317, 2.304 and 5.849 meq./ kg of fat in multilayer, LDPE and kraft paper respectively. Here it can be noticed that the deterioration in the fat due to which there is an increase in the rancidity is mainly contributed by the increase in moisture.

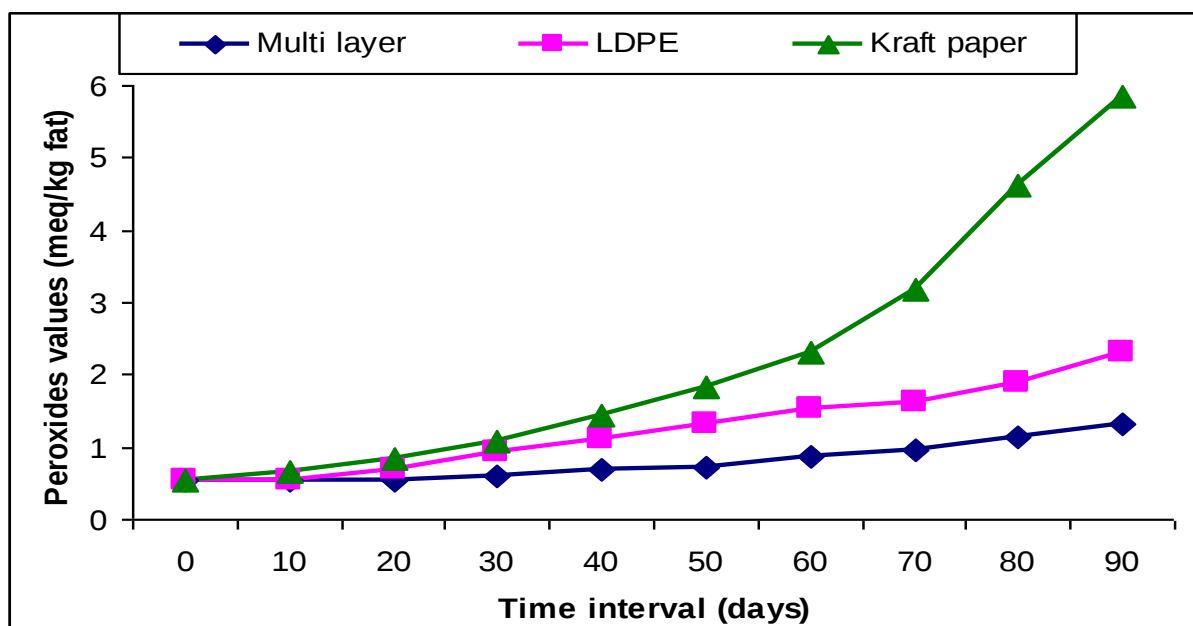


Fig. 4. Peroxide value (meq. / kg of fat) of the packed product under accelerated condition in different packaging materials at different time interval

Free fatty acid contents increase with storage due to the higher activity of lipase and lipoxidase which accelerates the release of free fatty acids. At moisture contents greater than 12%, risk of fat oxidation and development of rancidity increases as compared to flour containing lower levels of moisture i.e. 7.5% (Kent and Evers, 1994). Butt (2005) an increase in peroxide value (POV) during 60 days storage was due to development of rancidity. The means for peroxide value showed that this parameter increased from 0.53 to 0.99 meq per kg during 60 days storage. At moisture content greater than 12%, risk of fat oxidation and development of rancidity increases (Kent & Evers, 1994).

Change in colour

Lorenz and Dilsaver (1980) had done the colour measurement of the milled proso millet flour. Due variation in the ratio of amount of wheat and proso millet, it was found that the variation in colour was occurred which was represented as Hunter colour difference meter. Due to the absence of research of similar product no colour data is available for the

comparison. In this current research of colour, the standard is taken as $L^*=83.64$, $a^*=2.47$ and $b^*=10.59$ which is the initial value of the colour of the product.

$$\Delta L = L_{\text{sample}} - L_{\text{standard}}$$

$$\Delta a = a_{\text{sample}} - a_{\text{standard}}$$

$$\Delta b = b_{\text{sample}} - b_{\text{standard}}$$

+ ΔL means the sample is lighter than the standard, - ΔL means the sample is darker than the standard, + Δa means the sample is redder than the standard, - Δa means the sample is greener than the standard, + Δb means the sample is yellower than the standard and - Δb means the sample is bluer than the standard. L^* after 90 days 78.96, 78.04 and 74.00 which was 83.64 initially and a^* after 90 days is 3.72, 3.83 and 4.23 which was 2.47 initially and b^* values 12.80, 13.90 and 14.78 initial being 10.39 for multilayer, LDPE and kraft paper respectively. It is thus clear that the product became darker, redder and yellower than the initial. The total colour (ΔE) difference at different time interval in different packaging materials.

The total colour (ΔE) difference at different time interval in different packaging materials is shown in the fig. Where, $\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$

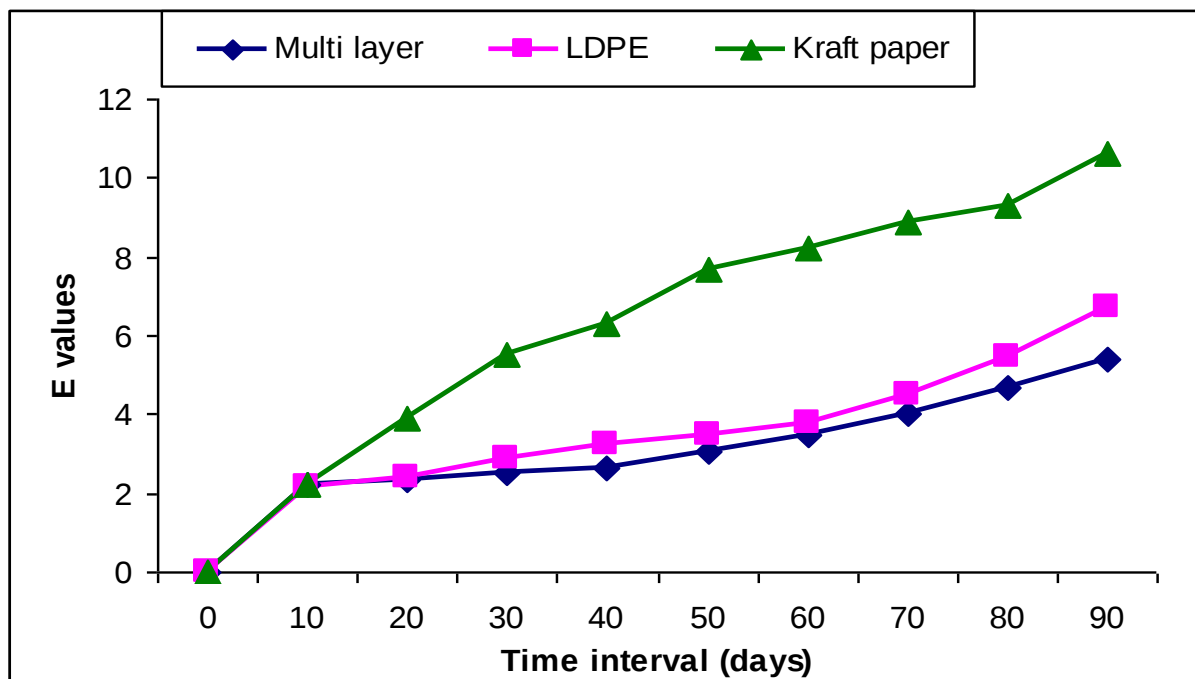


Fig. 5. Hunter Lab colour difference meter of the packed product under accelerated condition in different packaging materials at different time interval (ΔE)

The products was packed in 3 different packaging materials and exposed to accelerated condition. The change in the colour difference from initial 0 to 5.410, 6.747 and 10.637 in multilayer, LDPE and kraft paper respectively.

CONCLUSION

Multilayer was found to be the best in terms of storage of composite flour with respect to the parameters concerned. The composite flour packed in multilayer was least degraded when compared to kraft paper and LDPE. The major objective of the present investigation was to find out the best and cost economic packaging material for packaging and storage of composite flour. The cost of LDPE was Rs 0.60 for one kg pack of composite flour while, multilayer and kraft paper cost Rs. 1.40 and Rs. 0.80, respectively for the same quantity of flour. Though, the cost of multilayer packaging material was slightly higher than the other two packaging materials, looking at the final quality of the stored product it is was found to be more effective in increasing the shelf life of composite flour and hence it could be concluded that multilayer packaging material could be suitably used for packaging of composite flour.

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