EFFECT OF DIFFERENT ENVIRONMENTS AND PHYSICAL CONDITIONS ON SHELF-LIFE OF FULL FAT SOYFLOUR

P.C. BARGALE, K.C. JOSHI AND KRISHNA JHA

Central Institute of Agricultural Engineering (ICAR)

Nabi Bagh, Berasia Road, Bhopal - 462 018 (M.P.)
INDIA

ABSTRACT

Full fat soyflour (FFSF) is a promising soy-product with high protein, fat and calories for population which suffers from protein-calorie malnutrition. It can be used by blending with local dishes of cereals/pulses/ millets. The main constraint has been the poor keeping quality of FFSF under adverse environment because of its inherent qualities. Efforts were therefore made to improve the shelf-life of FFSF in accelerated environment of high temperature/low humidity (40°C/20% RH) through use of various packaging materials viz. laminates of, polyster/Al.foil/LDPE; paper/Al. foil/LDPE; Al. foil/paper/wax coated paper, and low density polyethene (LDPE) of two different thicknesses. The packed flour was analysed initially and periodically thereafter at 15 days interval to measure the deterioration in its quality through determining the level of free fatty acids, nitrogen solubility index, moisture content, insect infestation and change in colour. The results indicated that all the laminates and LDPE pack with higher thickness (125 micron) could help storing the flour suitably for the period of 60 days. The LDPE packs with lower thickness (62.5 micron) could store it only for 45 days at 40°C/20% RH. Though all the laminates were found suitable, considering the lower water vapour and gas transmission rate, better tensile strength, flexibility and printability, the laminate with 12 micron polyster/0.009 mm Al. foil/150 ga LDPE is recommended for short-term storage of full fat soyflour.

INTRODUCTION

Soybean with high protein and fat has emerged as an important nutritious food crop in last few decades with specific purpose to overcome the problem of calorie malnutrition existing in most of the developing countries including India. Significant progress has been made towards its utilization as food product. Full Fat Soyflour (FFSF) is one such promising soyproduct, which can be used in popular local Indian dishes such as chapati and halwa (Sushma, et. al. 1979). But due to rich nutritional value the soybased foods have poor keeping quality through microbial contaminants and enzymes like lipoxidase/proteases (Mattick and Hand, 1969; Mustaka et al. 1969; Wolf, 1975; and MacLeod and Ames, 1988). The oxidative rancidity may also develop due to non-enzymic decomposition of lipid hydroperoxides (Gardner, 1975). The deterioration of these products is further enhanced if storage environment is adverse either with high temperature or with high humidity. Under Indian climatic conditions, where in some parts the temperature is too high for quite long duration the storage of these products becomes a problem. The low temperature storage are costly and beyond the reach of small enterpreneurs/farmers. Improvement in shelf-life in such environment is, therefore, possible only through better packaging materials. Gandhi et al (1985) found that the metallic tins and polythylene (175 micron) packs could store the FFSF suitably during the period from April to January. The present study was therefore undertaken to find the suitability of five different packaging materials for storage of FFSF under warm conditions (40°C/20% RH) of storage. The results obtained have been presented in this paper.

MATERIALS AND METHODS

The full fat soyflour was produced by improved immersion cooking process (Gandhi et al 1984). The soybean (JS-72 44) produced at farm of Central Institute of Agricultural Engineering, Bhopal was used for this purpose. Five different packaging materials viz (i) P_1-12 micron polyster/ polyurethane adhesive/0.009 mm soft Al. foil/polyurethane adhesive/150 gauge low density polyethelene (ii) P_2-0.009 mm soft Al.foil adhesive/ 40 gsm poster paper/40 gsm wax (iii) P_3-.009 mm soft Al. foil/casein adhesive/ 60 gsm maplitho paper/150 gauge low density polyethelene (iv) P_4-low density polyethelene (125 micron) (v) P_5-low density polyethelene (62.5 micron) were selected for study . The laminate packages (P_1, P_2 and P_3) were obtained from M/s India Foils Ltd., Calcutta and LDPEs (P_4 and P_5) were obtained from local market in Bhopal. Packets of size (150 x 200 mm) were made using a thermal heat bar sealing machine. Each pack was filled with 500 g FFSF. The flour samples packed in different packages were placed in a humidity oven (make - scientronic) which was equilibrated for one week at 40±1°C/20±1% RH before storage studies began. Equal number of samples in similar packages (P_1 to P_5) were also put at room environment to serve as control. The temperature and humidity of the room were recorded using a thermohygrograph (make - Lambrecht, UK). The data obtained has been averaged for every two hour interval values so that the values represented the room environment which prevailed for most of the storage period. The samples packed and stored were analysed initially and periodically thereafter at 15 days interval till 60 days for nitrogen solubility index employing AACC (1969) method. The free fatty acids and moisture content were estimated by AOAC (1975). The period of 60 days was used for study since generally under this period from date of production the product in small packs (500-1000 g) are expected to be consumed. The samples were also examined visually for deterioration through insect infestation and change in colour. The results are average of triplicate analyses.

RESULTS AND DISCUSSION

Result of storage study at (40°C/20% RH) are given in Table 1 to 3. It is seen that there was a gradual increase in the FFA value during storage in all the packages in both environments. It was maximum in case of LDPE package (P_5) with lower thickness (62.5 micron) with an increase of more than 7 folds over initial value of 0.17%. This was followed by the LDPE pack (P_4) with higher gauge (125 micron) which showed an increase of 5.4 fold. The respective higher and lower values were 1.22 and 0.79%. The minimum increase was observed in package P_1, a laminate of polyster/Al.foil/150 ga LDPE. The increase in the sample at room environment was low compared to the controlled warm environment of 40°C/20% RH with maximum value of 0.80% in case of LDPE packages of thinner gauge (62.5 micron). This indicates that the deterioration/ rancidity was relatively lower at room environment (23.72°C/58.8% RH). The increase in FFA appear to have taken place through microbial hydrolysis dominated by moulds which are able to grow at water activity (Aw) of 0.8 and above. At room environment of 23.72°C/58.8% RH the increase in FFA was relatively low probably because most mesophillic microorganisms grow best between 25°C and 40°C. The possibility of auto oxidation can, however, be ruled out because the soybean used for preparation of this flour was blanched through 30 min boiling in water. In case of laminated packages (P_1, P_2, P_3) the increase in FFA was considerably low at both the environments. This was probably because their water vapour transmission rate (WVTR) and the gas transmission rate (GTR) values are almost zero and this favoured an aerobiocity leading to extremely low microbial activity.

The variation in moisture content (Table 2) indicate that at warm condition the moisture migrated from packaged flour to environment in spite of hydrolytic chemical reaction during storage, probably because at controlled environment (40°C/20% RH) the equilibrium moisture content was quite low and the flour had a natural tendency to attain it. But this does not appear to have achieved mainly because some moisture was added to flour because of hydrolytical reactions. The loss of moisture was maximum (46.5%) in case of LDPE package (P_5) because of its considerably high WVTR compared to the laminates (P_1 to P_3) in which maximum loss of moisture was of the order of only 7.5%, in the laminate of soft Al.foil/ maplitho paper/wax. The moisture content of flour stored at room environment clearly indicate gain in moisture in all the packages. This was mainly due to relatively higher RH (58.8% RH) and lower temperature (23.72°C) compared to controlled warm climate (40°C/20% RH). In this environment also the maximum gain in moisture (more than 10%) was in LDPE package (P_5).

The value of NSI (Table 3) indicate the decrease in its value with period of storage. This decrease was significantly higher in samples stored at warmer climate (40°C/20% RH) compared to the samples stored at room environment. The maximum decrease (more than 20%) was in case of LDPE package with lower thickness (P_5) stored at warmer climate. While the maximum decrease at room environment was only 8.92% in case of same package (P_5). The relatively higher decrease in values of NSI at warmer climate was probably due to considerably higher temperature of storage. The higher temperature for longer duration is always considered detrimental to the nitrogen solubility. The decrease was also due to increase in solubility of protein due to biochemical changes during storage. Similar results were observed by seth et al (1989) and Saio et al (1982). In case of NSI also the laminated packages (P_1 to P_3) were found to be more effective in both the studied environments. Neither any insect infestation nor any change in colour was observed in any of the package studied in both the environment.

CONCLUSIONS

On an overall basis it is seen that the three laminates (P_1 to P_3) studied were found to be more effective compared to the LDPE packages (P_4 and P_5) in both the environments. On the basis of permissible limit value (Mustakas et al 1964) of FFA (0.99%) for FFSF it is found that all the laminates and LDPE pack with higher gauge (125 micron) stored the flour safely for a studied period of 60 days under both environments. The LDPE packages (P_5) with lower thickness (62.5 micron) could store flour for 45 days at controlled warm climate (40°C/20% RH) and for 60 days at relatively moderate environment (23.72°C/58.8% RH).

Although all the laminates used in the study stored the FFSF suitably but the package with laminates of 12 micron polyster/polyurethane adhesive/0.009 mm soft Al.foil/polyurethane adhesive/150 gauge LDPE may be preferred over others since it has very low water and gas transmission rate, better tensile strength, flexibility and printability. These qualities make it more appropriate package for use during packaging, handling, transportation and marketing. However, if economy requires greater consideration the LDPE package with higher gauge (125 micron) may also serve the purpose for storage of full fat soyflour under warm conditions.

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Table 1 : Changes in free fatty acid (FFA) values of full fat soyflour during storage at (40±1)°C/(20±1)% RH and at ambient condition (23.72°C/58.8% RH) in different packaging materials.

Storage period, days	free fatty acid (as % oleic acid)									
	at (40±1)°C/(20±1)% RH and in package					at ambient (control) 23.72°C/58.8% RH in package				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
0	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
15	0.23	0.26	0.23	0.30	0.32	0.21	0.23	0.22	0.27	0.30
30	0.36	0.44	0.30	0.49	0.58	0.32	0.36	0.33	0.39	0.51
45	0.50	0.57	0.59	0.76	0.93	0.39	0.46	0.47	0.54	0.65
60	0.66	0.71	0.70	0.92	1.22	0.50	0.57	0.60	0.71	0.80

P1 - 12 micron polyster/polyurethane adhesive/0.009 mm soft Al.foil/polyurethane adhesive/150 gauge low density polyethelene.

P2 - 0.009 mm soft Al.foil/adhesive/40 gsm poster paper/40 gsm wax.

P3 - 0.009 mm soft Al.foil/case in adhesive/60 gsm maplitho paper/150 gauge low density polyethelene.

P4 - Low density polyethelene (125 micron thick)

P5 - Low density polyethelene (62.5 micron thick)

Table 2 : Changes in moisture content of fullfat soyflour during storage at (40±1)°C/(20±1)% RH and at ambient condition (23.72°C/58.8% RH) in different packaging materials.

Storage period, days	moisture content, % (wb)									
	at (40±1)°C/(20±1)% RH and in package					at ambient (control) 23.72°C/58.80% RH and in package				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
0	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
15	7.61	7.56	7.64	6.91	6.63	7.77	7.80	7.84	7.82	7.90
30	7.48	7.41	7.50	6.03	5.74	7.81	7.88	7.96	7.96	8.06
45	7.36	7.28	7.41	5.50	4.92	7.86	7.91	7.99	8.12	8.20
60	7.29	7.12	7.32	5.06	4.12	7.92	8.00	8.06	8.24	8.48

P1 - 12 micron polyster/polyurethane adhesive/0.009 mm soft Al.foil/polyurethane adhesive/150 gauge low density polyethelene.

P2 - 0.009 mm soft Al.foil/adhesive/40 gsm poster paper/40 gsm wax.

P3 - 0.009 mm soft Al.foil/case in adhesive/50 gsm maplitho paper/150 gauge low density polyethelene.

P4 - Low density polyethelene (125 micron thick)

P5 - Low density polyethelene (62.5 micron thick)

Table 3 : Changes in nitrogen solubility index of full fat soyflour during storage at (40±1)°C/(20±1)% RH and at ambient condition (23.72°C/58.8% RH) in different packaging materials.

Storage period, days	nitrogen solubility index (%)									
	at (40±1)°C/(20±1)% RH and in package					at ambient (control) 23.72°C/58.8% RH and in package				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
0	16.69	16.69	16.69	16.69	16.69	16.69	16.69	16.69	16.69	16.69
15	16.60	16.58	16.54	16.37	16.23	16.60	16.60	16.50	16.53	16.31
30	16.32	16.30	16.40	16.13	15.82	16.51	16.44	16.41	16.32	16.13
45	16.00	15.82	16.12	15.66	15.13	16.37	16.20	16.11	15.92	15.79
60	14.32	14.22	14.14	13.96	13.33	16.10	15.94	15.86	15.52	15.20

P1 - 12 micron polyster/polyurethane adhesive/0.009 mm soft Al.foil/polyurethane adhesive/150 gauge low density polyethelene.

P2 - 0.009 mm soft Al.foil/adhesive/40 gsm poster paper/40 gsm wax.

P3 - 0.009 mm soft Al.foil/case in adhesive/60 gsm maplitho paper/150 gauge low density polyethelene.

P4 - Low density polyethelene (125 micron thick)

P5 - Low density polyethelene (62.5 micron thick)

LES EFFETS DE DIFFERENTS ENVIRONNEMENTS ET CONDITIONS PHYSIQUES SUR LA DUREE DE VIE DE LA FARINE DE SOJA COMPLETE

P.C BARGALE, K.C. JOSHI et Krishna JHA

Central Institute of Agricultural Engineering (ICAR)
Nabi Bagh, Berasia Road, Bhopal-462 018 (M.P.), India

RESUME

La farine de soja non dégraissée (FFSF) est un dérivé de soja possédant un taux élevé de protéines, de graisses et de calories, prometteur pour les populations souffrant de malnutrition. Elle peut s'utiliser en mélange avec des produits locaux, céréales, légumineuses, millet. Son seul inconvénient reste sa mauvaise conservation dans un milieu peu favorable en raison même de ses qualités spécifiques. Des études ont donc été entreprises pour améliorer sa durée de vie dans des conditions d'oxygénation accélérées, à température élevée et degré d'humidité bas (40° C /20 % HR). Dans ce but, on a utilisé divers emballages feuilletés ; polyester/feuille d'aluminium/polyéthylène de basse densité (LDPE) ; papier/feuille d'alu/LDPE : feuille d'alu/papier/papier huilé, et deux épaisseurs de LDPE. La farine de soja emballée à été analysée préalablement puis périodiquement à 15 jours d'intervalle pour déterminer le degré de dégradation de sa qualité par mesure de son contenu en acides gras libres, son indice de solubilité dans l'azote, son degré d'humidité, son infestation par les insectes et son changement de couleur. Les résultats ont montré que tous les emballages feuilletés et tous les emballages LDPE à deux épaisseurs (125 µm) permettaient une conservation convenable de 60 jours. Les emballages LDPE d'une épaisseur moindre (62,5 µm) n'étaient efficaces que pendant 45 jours à 40° C/20 % HR. Bien que l'on ait montré que tous les emballages feuilletés pouvaient convenir pour le stockage de courte durée de la farine de soja non dégraissée, on recommande celui en polyester de 12 µm/0,009 mm d'alu/150 ga LPLD, compte tenu de son bas niveau de transmission des gaz et de la vapeur d'eau, son excellente résistance à la tension et sa flexibilité ainsi que le fait qu'il s'imprime facilement.