Effect OF Moisture and Packaging on the Shelf Life of Wheat Flour

Masood Sadiq Butt, Muhammad Nasir, Saeed Akhtar and Kamran Sharif.
Institute of Food Science & Technology, University of Agriculture, Faisalabad.

ABSTRACT

Tempering of the wheat samples with different amounts of water was done to obtain flour treatments having different moisture levels i.e. T_1 (13.5%), T_2 (13%), T_3 (12%), T_4 (11%), T_5 (10%) and T_6 (9%) after milling. These treatments were separately packed in polypropylene and paper bags. During the storage period of 60 days, each treatment in both polypropylene and paper bags was evaluated for proximate composition, insect infestation, mold growth and total iron. The crude protein and crude fat decreased with storage period. Moisture content (m.c) in T_1 (13.5% m.c.), T_2 (13% m.c.) and T_3 (12% m.c.) decreased. Changes were minimum in T_4 (11% m.c.) and increasing trend was seen in T_5 (10% m.c.) and T_6 (9% m.c.). The changes were more in polypropylene than in paper bags. Changes in ash and fiber were non significant during the study. Insect infestation and mould growth were also favored by higher moisture content of flour. Paper packaging was found to be suitable against insect infestation and mould growth. Total iron also showed a decreasing trend with storage period. Lower flour moisture (T_6= 9%) and paper packaging were found to be suitable for storage stability & longer shelf life of wheat flour.

INTRODUCTION

In Pakistan, wheat is mainly milled to whole wheat flour for the production of unleavened flat bread locally known as “Chapati” while rest is used for other bakery products like bread, biscuits, cakes, pastries, pizzas etc. The annual production of wheat in Pakistan is 19.23 million tones and the area covered is 8.69 million hectares (Anon. 2003).

Moisture content of flour is very important regarding its shelf life, lower the flour moisture, the better its storage stability. The deterioration of baking quality is also less at lower moisture content which can be credited to retarded respiration and activity of microorganisms (Staudt and Zeigler, 1973)

Moisture is an important factor in controlling grain infestation. Insects that live on stored grains and their products depend upon the moisture supply. Generally, moisture content of 9% or lower restricts infestation. Moisture is also of great importance for the safe storage of cereals and their products regarding microorganisms, particularly certain species of fungi. At lower moisture fungi will not grow but at about 14% or slightly above, fungal growth takes place (Hoseney, 1994).

Higher lipolytic and proteolytic activities are related to higher moisture content, which further lead to loss in nutrients (protein and fat) and production of more FFA resulting in inferior sensory characteristics.

In modern age, food packaging has become very important because of protection of the product from contamination by macro & micro-organisms and their filth, prevention from loss or gain of moisture, shielding the product from oxygen and to facilitate handling (Ball, 1960).

Good packaging actually serves two purposes, which are essentially technical and presentational. Technical aspects in packaging aim to extend the shelf life of the food by better protection from all the hazards during storage. Presentational aspects are not concerned with shelf life but such packaging increases sales by creating a

brand image that the buyer instantly recognizes (Peter and Axtell, 1993).

Presently packaging materials being used in Pakistan for flour are jute, cotton and polypropylene. These packages do not protect the wheat flour properly from contamination by insect pests, microbes, sand, dust and environmental moisture.

In climate like Pakistan the shelf life of flour is a serious problem and due to weather conditions it is inevitable to explore proper packaging material & moisture content to over come existing dilemma.

The present project was designed to extend the shelf life of flour by determining the proper moisture and packaging material for safe storage and to find out most suitable combination of moisture content and packaging material for flour stability.

MATERIALS AND METHODS

Wheat Polypropylene bags and multiwall (3 layers) kraft paper bags were purchased from the local market of Faisalabad.

Preparation of Whole Wheat Flour Samples

Tempering of wheat samples was done at different moisture levels which were followed by milling and packaging to obtain wheat flour samples having different moisture content i.e. 13.5, 13, 12, 11, 10 and 9% (Table 1).

Treatment	Moisture content of wheat (%)	Moisture content of tempered Wheat (%)	Moisture content of flour after Packaging (%)	
			Polypropylene bags	Multiwall paper bags
T_1	8.4	17.50	13.51	13.51
T_2	8.4	17.00	13.02	13.02
T_3	8.4	16.00	12.01	12.01
T_4	8.4	15.00	11.01	11.01
T_5	8.4	14.00	10.02	10.02
T_6	8.4	13.00	9.00	9.00

Table 1. Different Treatments Used In Study

Analysis of Different Treatments of Whole-Wheat Flour During Storage

Proximate Analysis

Each treatment was analyzed fortnightly up to 60 days for moisture, crude protein, crude fat, crude fiber, total ash, and NFE by following their respective procedures described in AACC (2000).

Estimation of Iron

Iron content was estimated with the interval of 15 days up to 2 months by using spectrophotometer according to method described in AOAC (1990).

Counting of Molds

Counting of molds was done by serial dilution or agar plate technique on Sabouraud agar medium at 0, 15, 30, 45 and 60 days using the method described by Beneke (1962).

Insect Infestation

Insect eggs in wheat flour were observed by iodine method and insect hairs were determined by clove oil method fortnightly for two months of storage, according to method described in AACC (2000). Visual observation was also carried out to observe insect larvae and adults.

Statistical Analysis

The data obtained from each treatment was subjected to statistical analysis to determine analysis of variance within the treatments, packaging material & storage intervals and interactions among

these parameters as described by steel *et al.* (1997).

RESULTS AND DISCUSSIONS

Proximate Composition of Whole-Wheat Flour During Storage

The moisture content was affected significantly due to storage, treatments, packaging and their interaction (Table 2,3,4).

The moisture content of T_1, T_2, T_3, and T_4 decreased with storage period upto 45 days and then increased afterwards. The initial decrease was due to relatively low relative humidity in atmosphere. After 45 days of storage, higher relative humidity in atmosphere caused the flour moisture to increase upto end of storage. However, the changes were more in samples having higher initial moisture content. The moisture in T_5 and T_6 increased throughout the storage period. This increase was due to their lower initial moisture content. Between the packaging materials, the flour in paper bags showed less change in moisture content. These changes in moisture content during storage were due to the hygroscopic properties of flour. The results are collaborated by the earlier findings of Rehman and Shah (1999) and Kirk and Sawyer (1991).

The results pertaining to the crude protein content showed a decreasing trend with storage. Among the treatments the decrease was more in treatments having higher moisture because higher moisture content in wheat flour favored proteolytic activity. After 45 days the crude protein of the samples having higher moisture levels increased due to insect infestation and microbial growth. Changes in protein in paper bags were also lower than in polypropylene bags. These results are in close agreement with the results obtained by Leelavathi *et al.* (1984) and Upadhyay (1994).

The crude fat decreased during the storage period. The decrease may be attributed to the lipolytic activity of enzymes i.e. lipase and lipoxidase. The lipolytic activity was lower in paper bags than in polypropylene.

Table 2 Mean values for effect of treatments on proximate composition, total iron, & colonies of molds

Treatments	Moisture content (%)	Crude protein (%)	Crude Fat (%)	Crude Fiber (%)	Total Ash (%)	NFE (%)	Total Iron mg/Kg	Colonies of Moulds
T_1	11.84	10.95	2.06	2.49	1.72	69.78	40.17	709
T_2	11.67	11.10	2.07	2.48	1.71	69.94	40.17	641
T_3	11.33	11.30	2.08	2.49	1.71	70.27	40.06	560
T_4	10.95	11.37	2.09	2.49	1.70	70.72	40.17	463
T_5	10.57	11.40	2.09	2.50	1.7	71.03	40.21	390
T_6	9.79	11.42	2.10	2.49	1.7	71.88	40.19	328

T_1= 13.5% m.c. T_2= 13% m.c. T_3= 12% m.c.

T_4= 11% m.c. T_5= 10% m.c. T_6= 9% m.c.

Table 3 Mean values for effect of storage period on proximate composition, total iron, & colonies of molds

Storage Period (Days)	Moisture content (%)	Crude protein (%)	Crude Fat (%)	Crude Fiber (%)	Total Ash (%)	NFE (%)	Total Iron mg/Kg	Colonies of Moulds
0	11.43	11.93	2.12	1.71	1.72	70.01	41.26	152
15	11.16	11.80	2.10	2.5	1.71	70.44	40.72	241
30	10.86	11.72	2.08	2.49	1.70	70.83	40.20	575
45	10.74	11.60	2.07	2.49	1.70	70.92	39.56	685
60	10.83	11.49	2.05	2.49	1.70	70.80	39.07	926

Table 4 Mean values for effect of packaging material on proximate composition, total iron, & colonies of molds

Packaging Material	Moisture content (%)	Crude protein (%)	Crude Fat (%)	Crude Fiber (%)	Total Ash (%)	NFE (%)	Total Iron mg/Kg	Colonies of Moulds
Polypropylene bags	10.97	11.79	2.08	2.49	1.70	70.56	40.14	521
Paper bags	10.98	12.04	2.09	2.49	1.70	70.63	40.15	494

Table 5 Mean values for effect of storage, packaging material and treatments on the insect infestation in whole-wheat flour

Treatment	Packaging Material	Storage Period				
		0 days	15 Days	30 Days	45 Days	60 Days
T_1	Poly propylene bags	-	-	+	++	+++
	Multiwall paper bags	-	-	-	-	+
T_2	Poly propylene bags	-	-	+	++	+++
	Multiwall paper bags	-	-	-	-	+
T_3	Poly propylene bags	-	-	-	+	++
	Multiwall paper bags	-	-	-	-	-
T_4	Poly propylene bags	-	-	-	-	+
	Multiwall paper bags	-	-	-	-	-
T_5	Poly propylene bags	-	-	-	-	--
	Multiwall paper bags	-	-	-	-	-
T_6	Poly propylene bags	-	-	-	-	-
	Multiwall paper bags	-	-	-	-	-

+++ = Infestation with the presence of live insects ++= Infestation with the formation of lumps
+ = Slight infestation with the formation of lumps - = No Infestation

Paper bags provided more protection against the oxygen in the atmosphere to come in contact with flour. The results closely resemble the results obtained by Haridas (1983) and Leelavathi *et al*. (1984) who also reported the similar trend of decrease in crude fat during storage. Crude fiber and ash were not affected during the study.

Iron Content

Total iron decreased with storage period; however, packaging material, treatments and interaction did not have impact upon this decrease(Table 2,3,4). Results are collaborated with Rubin *et al*. (1997) and Misfa *et al*. (2000) who also observed reduction of iron during storage.

Colony Count of Molds

The results for colonies of during storage showed that the molds differed significantly with respect to treatments, storage period packaging material and interaction between all these parameters (Table 2,3,4). Higher moisture content favored mold growth. Mold growth was also less in paper bags than in polypropylene bags.

Results of present investigation are comparable with those found by Bothast *et*

al. (1991) and Upadhyay *et al*. (1994) who also seen similar trend during storage.

Insect Infestation

Insect infestation in different treatments in both packaging was monitored by observing insect eggs, insect hair microscopically and adults by visual examination. The results obtained with regard to insect infestation indicated that infestation was favored by higher moisture in flour (Table 5). Paper bags provided more protection against insect infestation than polypropylene bags as. Similar results were found by Leelavathi *et al*. (1984) and Upadhyay *et al*. (1994).

CONCLUSION

The present study reveals that T_6 having 9% moisture content and T_5 having 10% moisture content in multiwall kraft paper bags provided maximum protection against insect infestation and mold growth. The physico-chemical changes were also lower in these treatments. Multiwall kraft paper bags were found to be effective against mould growth, insect infestation, lipolytic activities, proteolytic activities and moisture changes. So the flour having 9% moisture content (T_6) was proved to be most appropriate regarding the shelf life of wheat flour.

REFERENCES

AACC. 2000. Approved Methods of American Association of Cereal Chemists. Am. Assoc. of Cereal Chem., Inc. St. Paul. Minnesota.

Anonymous. 2003. Economic Survey. Govt. of Pakistan, Economic Advisor's Wing, Finance Division, Islamabad.

Ball, C. O. 1960. Here are effects on color changes in packaging of fresh meat cuts. Natl. Provisional 143 (47): 10-12.

Beneke, E. S. 1962. Medical Mycology. Lab. Manual Burgess Pub. Co. Minneapolis, Minnesota. 21: 68-71.

Bothast, R.J., R.A. Anderson, K. Warner and W. F. Kwolek. 1991. Effects of moisture and temperature on microbiological and sensory properties of wheat flour and corn meal during storage. Cereal Chem.42 (3): 187-190.

Din, S.A. 1998. Chemical and Functional Properties of Atta Prepared by Different Roller Flour Mills and China Mills. M.Sc. (Hons.) Thesis, Department of Food Technology, University of Agriculture, Faisalabad.

Hoseney, R.C. 1994. Principles of Cereal Science and Technology. 2nd ed. Am. Assoc. of Cereal Chem. Inc., St. Paul, Minnesota, USA.

Kirk, S.R. and R. Sawyer. 1991. Pearson's Composition and Analysis of Foods. Addison-Wesley Longman Ltd. Edinburg Gate, Harlow, England.

Leelavathi, k., P. H. Rao, D. Indrani and S. R. Shurpalekar. 1984. Phisco-chemical changes in whole wheat flour (Atta) and resultant atta during storage. J. Food Sci. Tech.

Haridas, P. R., K. Leelavathi and S. R. Shurpalekar. 1983. Comparative studies on atta (whole wheat flour) and resultant atta a by-product of roller flour milling industry. J. Food Sci. Tech. 20(1): 5-8.

Misfa. H., S. Rehman, N. Huma and F. Rafiq. 2000. Studies on wheat atta fortified with elemental iron used for chapati production. Pak. J. Food Sci. 10(3-4): 5-7.

Peter, F. and B. Axtell. 1993. Appropriate Food Packaging. Publ. Transfer of Technology for Development-Amsterdam, International Labour office, Geneva.

Rehman, Z. U. and W. H. Shah. 1999. Biochemical changes in wheat during storage at three temperatures. Plant Food for Human Nutri. 54 (2): 109-117.

Rubin, S. H., A. Emisi and L. Scalpi. 1977. Micronutrient addition to cereal grain products. Cereal Chem. 54(4): 895-903.

Samuels, R. and R. Modgil. 1999. Physico-chemical changes in insect infested

wheat stored in different storage structures. Journal of Food Sci. & Tech., 36 (5): 479-482.

Staudt, E. and Ziegler. 1973. Flour Chemistry 1st ED. Bhuler Brothers Ltd., Engineering Works 9240 Uzwil, Switerzerland.

Steel, R., J. H. Torrie, and D. Dickey. 1997. Principles and Procedures of Statistics. A biometrical Approach, 3rd Ed. McGraw Hill Book Co. Inc. New York.

Upadhyay, R. K., M. Thangaraj and P. k. Jaiswal. 1994. Storage studies of suji in different packages. Journal of Food Sci. & Tech., 31 (6): 494-496.