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EFFECT OF DIFFERENT ANTOXIDANTS AND PACKAGING MATERIALS ON THE STORAGE STABILITY OF BREAKFAST CEREALS

M. S. BUTT[1], AMJAD ALI[1], IMRAN PASHA[1,] ABDUL MOEED HASHMI[1] and SARWAR DOGAR[2]

[1] Department of Food Technology, University of Agriculture, Faisalabad-Pakistan.
[2] Fauji Cereals RawalPindi-Pakistan.

SUMMARY

Ready-to-eat breakfast cereal with nuts was made by mixing different processed grains like wheat, barley, rice, corn with almonds, walnuts and dry skimmed milk powder according to recipe. Antioxidants Butylated hydroxy anisole (BHA) and Butylated hydroxyl toluene (BHT) were used for almonds and walnuts at 0.02% levels. The effect of packaging materials like Bi-Oriented polypropylene (BOPP), High density polyethylene (HDPE) and Aluminium foil were observed. The chemical analysis such as moisture, protein, fat, ash, fiber and carbohydrates of the product were determined. Since moisture, rancidity, acidity, and peroxide value are main factors which affect the storage life of breakfast cereals, so these factors were measured at intervals of 15 days up to six months. During storage, sensory evaluation for color, taste, flavor, mastication and overall aceptability were also evaluated. The data thus obtained was statistical analyzed and best treatment was chosen. It was concluded that moisture, acidity and peroxide value of the product were increased with the passage of time. The moisture absorption was least in Aluminium foil due to its moisture barrier properties. The acidity was increased due to oxidation of fats and peroxide value due to increase in hydro peroxides. The treatment BHT (0.02%) in Aluminium foil performed best in enhancing shelf life by inhibiting molecular oxidation of fats present in the product. The treatment BHA/ BHT (0.02%) in Aluminium foil also enhanced shelf life of the product.

INTRODUCTION

Food is one of the basic necessities of life and there are different sources of food such as cereals, meat, vegetables, fruits, milk and milk products etc. In almost all over the world cereals are used as staple food. Cereal grains are cheapest source of energy and protein in human diet. In Pakistan, per capita availability of cereals is 155.6 kg/year that provides 1399 calories and 35g of protein per day (FAO, 1996).

Breakfast cereals have been defined as "processed grains for human consumption" (Fast, 1987). One or more of the cereal grain or milled fractions thereof are indeed constituents of all breakfast cereals. The principle grains used in breakfast cereals are corn, wheat, rice, oats, and barley. The common breakfast cereals are cereal flakes and porridge. There is a dire need to enhance the nutritional value of breakfast cereals. For this purpose different nuts like almonds and walnuts were added in the breakfast cereal. These nuts due to their susceptibility to rancidity reduce the shelf life of the product. Diversification of breakfast

cereal products is consumer oriented demand and ways and means to tackle the problems with its shelf life are to be figured out by using different means. Addition of antioxidants to cereals containing fatty nuts is one of these techniques. Antioxidant can be defined as any substance, which is capable of delaying, retarding or preventing the development of rancidity or other oxidative flavor are corn, wheat, oats, rice and barley (Fast and Caldwell, 1990).

Antioxidants are widely used as food additives to improve oxidation stability of lipids and to prolong shelf-life, mainly for dried products and O_2- sensitive foods. Antioxidants can also be incorporated into plastic films for polymer stabilization in order to protect the films from degradation (Vermeiren *et al*., 1999). The common breakfast cereals are cereal flakes and porridge deterioration in foods (Coppen, 1983). All the major antioxidants provide protection to grains and cereals, dry breakfast cereals are often stabilize by inclusion of antioxidants especially BHA and BHT (Buck, 1991).

Packaging is a mean of providing the correct environmental conditions for food. Foods are affected by different environmental factors and hence have different packaging needs. The major packaging materials used today for cereals are synthetic polymers and Aluminium foil. The chief advantage of Aluminium foil is its moisture transmission rate, which is approximately zero percent, when material is properly used.

The rancidity is the major problem in breakfast cereals containing nuts. That is why the breakfast cereals with nuts have short storage life. These can possibly be controlled if fat of almonds and walnuts used in breakfast cereal is protected from deterioration. So keeping this in view, the present plan of research was undertaken to study the effect of different antioxidants on the storage stability of the breakfast cereal containing nuts.

MATERIALS AND METHODS

Preparation of product

Recipe:	
Roasted wheat Porridge	25g
Roasted barley Porridge	15g
Skimmed Milk Powder	10g
Corn Flakes	10g
Rice Flakes	10g
Wheat Flakes	10g
Almonds	10g
Walnuts	10g

Processing of different cereal grains like corn, wheat, and rice into ready to-eat flaked cereals was carried out by following different traditional processing steps like degermination, mixing, cooking, depluming, tempering, flaking, and toasting while processing of roasted porridge food consists of cleaning, de-stoning, tempering, depluming, gelatinization, rolling and roasting at Fauji Cereals Rawalpindi. While almonds, walnuts and skimmed milk powder will be procured from local market. Nuts were cut, sliced and then mixed in different ratios according to recipe. Before mixing, almonds and walnuts after slicing, divided into four lots for treatments with antioxidants at 0.02% BHA, 0.02% BHT, (0.01+0.01) 0.02% BHA/BHT. Nuts after treatment with antioxidants were mixed along skimmed milk powder with flaked cereals by using ribbon mixer and then packaged into BOPP, HDPE and Aluminium foil. Before packaging proximate composition of the product was determined by using (AACC, 1983) methods.

Physico-Chemical analysis

Proximate analysis such as moisture, fat, protein, ash, crude fiber, and carbohydrates were carried out after preparation of the product before packing, while rancidity, peroxide value and moisture were determined at interval of 15 days upto six months. American Association of Cereal Chemists (AACC, 2000) methods were followed for all analytical work.

Sensory evaluation

The product under each treatment was organoleptically evaluated for color, flavor, taste, mastication, and overall acceptability with 15 days interval upto six-months. A 9-point hedonic scale and a panel of 5-trained judges from Fauji Cereals Rawalpindi were selected for evaluation as described by Larmond (1977).

Statistical Analysis

Statistical analysis will be made on the basis of data collected by using Two-Factorial Complete Randomised Design (CRD) as described by Steel and Torrie (1980).

RESULTS AND DISCUSSIONS

The moisture of the prepared product increased during storage in all samples. The results from table: 2 showed that maximum moisture absorption was in BOPP, while in Aluminium foil moisture absorption was negligible and HDPE was intermediate in moisture gain. The least moisture absorption in Aluminium foil was due to its moisture barrier properties. The results are similar to earlier findings of (Matz, 1976).

The results regarding acidity of the product from table: 1 showed that maximum acidity was in control treatments T_1, T_2 and T_3, because these treatments are without antioxidants. The least acidity was found in T_9 (Aluminium foil with BHT 0.02%) due to effectiveness of BHT (0.02%). The acidity in treatments T_4, T_5, and T_6 was found less than control treatments. The treatments T10, T_{11} and T_{12} were found having slightly higher acidity than T_9. The reason for increase in acidity is that rancidity increases the acidity of the product due to increase in number of peroxides. The results are in line with earlier findings of (Salim *et al,* 1986) and (Young and Cunningum, 1991) which reported that with the addition of almonds in cereal products the acidity increases due to presence of peroxides.

According to results from table: 1 the peroxide value of the product was maximum in control treatments T1, T2, and T3. The minimum peroxide value was reported in T_9 (Aluminium foil with BHT 0.02%). the peroxide value in treatments T_4, T_5, and T_6 was found less than control treatments. The treatments T10, T_{11} and T_{12} were found having higher peroxide value than T_9. The reason for increase in peroxide value is that oxidation of fat increases the peroxide percentage in the product. Same results were reported by (Eagan, 1981), who investigated that the peroxide value for fresh oils and fats is usually below 10 meq/kg and for rancid oils and fats is above 20meq/kg.

For determining the presence of rancidity in samples kries test was conducted 15 days interval upto six months. The results from table: 3 showed that samples in Aluminium foil with antioxidants showed best results after six months storage and no sample was found rancid because light reduces the effectiveness of an antioxidant and Aluminium foil protects the product from light. Another factor is that there was almost negligible moisture absorption in Aluminium foil so having these both properties Aluminium foil and BHT (0.02%) were best to protect the product from rancidity.

The results regarding sensory properties of the product from table: 2 showed that color and mastication of the product were almost same throughout six months storage and there was a non-significant difference in treatments. As for as taste, flavor and overall acceptability of the product were concerned, the maximum scores were given to treatment T_9 (Aluminium foil with BHT 0.02%), and minimum to T_1 (BOPP) control. The treatments T_6 (Aluminium foil with BHA 0.02%) and T_{12} (Aluminium foil with BHA/BHT 0.02%) were slightly low in scores than T_9

Table: 1 Mean values for effect of different antioxidants and packaging materials on moisture, acidity and peroxide value of the product

Treatments	Moisture (%)	Acidity (%)	Peroxide value (meq / kg)
T_1	7.299	0.294	20.891
T_2	6.677	0.280	18.292
T_3	6.361	0.264	12.854
T_4	7.298	0.247	16.348
T_5	6.677	0.256	14.375
T_6	6.346	0.249	9.432
T_7	7.300	0.248	14.371
T_8	6.676	0.246	13.428
T_9	6.312	0.243	8.470
T_{10}	7.223	0.247	16.275
T_{11}	6.679	0.250	13.832
T_{12}	6.332	0.254	8.959

Table: 2 Mean values for sensory evaluation of the product (0 to 180 days)

Treatments	Color	Taste	Flavor	Mastication	Overall acceptability	Grand Total
T_1	7.831	5.059	5.215	7.888	5.615	31.605
T_2	8.069	6.069	6.300	7.800	6.054	34.292
T_3	7.923	6.800	6.877	7.977	7.585	37.162
T_4	8.054	6.246	6.385	7.900	5.800	34.385
T_5	8.062	6.392	6.508	7.738	6.923	35.623
T_6	8.300	7.982	7.969	7.969	7.946	40.166
T_7	8.115	6.631	6.638	7.638	6.346	35.368
T_8	7.969	6.815	6.831	7.662	7.026	36.303
T_9	8.215	8.385	8.385	7.900	8.000	40.885
T_{10}	7.985	6.408	6.408	7.397	6.508	34.706
T_{11}	7.977	6.738	6.731	7.631	7.362	36.439
T_{12}	8.146	8.100	8.177	7.833	8.446	40.702

Table 3: Effect of antioxidants and packaging materials on rancidity of the product

Treatments	So 0 Days	S_1 15 Days	S_2 30 Days	S_3 45 Days	S_4 60 Days	S_5 75 Days	S_6 90 Days	S_7 105 Days	S_8 120 Days	S_9 135 Days	S_{10} 150 Days	S_{11} 165 Days	S_{12} 180 Days
T_1	A	A	A	A	A	A	P	P	P	P	P	P	P
T_2	A	A	A	A	A	A	A	A	P	P	P	P	P
T_3	A	A	A	A	A	A	A	A	A	A	A	P	P
T_4	A	A	A	A	A	A	A	A	A	A	P	P	P
T_5	A	A	A	A	A	A	A	A	A	A	A	A	P
T_6	A	A	A	A	A	A	A	A	A	A	A	A	A
T_7	A	A	A	A	A	A	A	A	A	A	A	P	P
T_8	A	A	A	A	A	A	A	A	A	A	A	A	P
T_9	A	A	A	A	A	A	A	A	A	A	A	A	A
T_{10}	A	A	A	A	A	A	A	A	A	A	P	P	P
T_{11}	A	A	A	A	A	A	A	A	A	A	A	A	P
T_{12}	A	A	A	A	A	A	A	A	A	A	A	A	A

KEY:P = Present **A** = Absent

Table: 4 Proximate composition of the product with and without nuts.

Composition	Without nuts %	With nuts %
Moisture	5.92	6.125
Fat	1.18	12.76
Protein	11.87	12.68
Ash	2.89	3.66
Fiber	0.89	2.94
Carbohydrates	77.25	61.84
Calories	367	414

but acceptable after six months storage. The remaining samples in treatments T_2, T_3, T_4, T_7, T_8, T_{10} and T_{11} were rancid and are not acceptable after whole storage.

SHELF LIFE OF THE PRODUCT

(Based on physico-chemical and sensory properties)

The problem of shortened shelf life due to the presence of nuts was studied by using different antioxidants and packaging materials over a period of six months. With the presence of oxygen and moisture, rancidity in oils starts earlier and life of product expires earlier. To eliminate oxygen and moisture transfer penetration into packets the samples were treated with antioxidants and packed in different packaging materials.

For determining the presence of rancidity in samples Kries test was conducted after every 15 days upto six months. From table: 3 results showed that three treatments T_6 (Aluminium foil with BHA 0.02%), T_9 (Aluminium foil with BHT 0.02%) and T_{12} (Aluminium foil with BHA/BHT 0.02%) were found non rancid after six months storage. The other treatments T_1 (BOPP) control, T_2 (HDPE) control were found rancid after 2.5 and 3.5 months respectively. The treatments T_5 (HDPE with BHA 0.02%), T_8 (HDPE with BHT 0.02%) and T_{11} (HDPE with BHA/BHT 0.02%) were found rancid after 5.5 months while treatments T_4 (BOPP with BHA 0.02%), T_{10} (BOPP with BHA/BHT 0.02%) and T_7 (BOPP with BHT 0.02%) were found rancid after 4.5, 4.5 and 5 months respectively. T_3 (Aluminium foil) control was found rancid after 5 months.

The above results indicate that antioxidants especially BHT 0.02% in Aluminium foil showed best results to avoid rancidity, because Aluminium foil protects the product from light. The light reduces the effectiveness of an antioxidant, so antioxidant is effective in Aluminium foil. Another factor is that there as almost negligible moisture absorption in Aluminium foil, so Aluminium foil and BHT were found best to protect product from rancidity.

ENRICHMENT OF THE PRODUCT

To achieve the enrichment of the product, different nuts were added in the product. The results from table: 4 showed that there was significant difference found in the proximate composition of the product.

According to results fat content was extremely increased from 1.18 to 12.76 percent. The reason for that increment is that both almonds and walnuts are rich source of lipids, because almonds contain 50% fat (Young and Cunningham, 1991) and walnuts 68% (Ravai, 1992). While in other components like protein, ash, and fibre percent increase was appreciable, because almonds and walnuts are also a good source of protein, fibre, and minerals (Stankovic, 1977).

CONCLUSION

Breakfast cereal with nuts was made to check the effect of different antioxidants and packaging materials on the storage stability of breakfast cereals. The results of physico-chemical analysis and sensory properties showed that samples in Aluminium foil with BHT (0.02%) were found best in taste, flavor and overall acceptability, and there were no sign of rancidity after six months storage. Therefore it is suggested that nuts used in cereal products should be treated with antioxidants to avoid rancidity. The cereals containing nuts should be packaged in Aluminium foil to reduce moisture absorption

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