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Influence of Storage Container on Keeping Quality of Bajra Grain : Relationship with Lipid Changes

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ABSTRACT

The moisture content and lipase activity decreased during storage while level of free fatty acids, peroxide value and malondialdehyde increased in bajra grains stored in aluminium tins or gunny bags for a period of one year. Storage of bajra grains in aluminium tins led to release of lower levels of free fatty acids and decreased formation of peroxides especially at the end of eight months.

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INTRODUCTION

Bajra (*Pennisetum americanum* L.) is one of the major cereal crops cultivated in India after rice and wheat. In spite of the greater availability, low cost and comparatively good nutritional value, use of bajra has been limited in food industry. The flour prepared from bajra has a poor shelf life and develops off flavours and bitter taste within a short period of ten days. Higher fat content in bajra seed is said to be the major cause for seed deterioration (Reddy *et al.*, 1986). Fatty acids are readily formed by lipases from fats in grain, particularly under storage conditions of high temperature and moisture content. Oxidative changes follow where the free fatty acids (FFA) are oxidized to peroxides and hydroperoxides and their break-down products (Faria, 1983). Studies on storage related chemical and biochemical changes are very few in bajra grain (Pruthi, 1981). In view of this, the present studies were carried out on lipid degradative changes during storage of bajra grain.

MATERIALS AND METHODS

Bajra storage

Bajra (BJ 104 variety) grains were cleaned to remove extraneous matter. 500g quantities were stored in separate aluminium tins or gunny bags for each replication. The same were stored under ambient conditions for a period of one year from October 1984 and samples were withdrawn for analysis at 0, 4, 8 and 12 months.

Analytical techniques :

Moisture

Moisture content was determined as loss of weight of the grain after drying in the oven at 105°C for five hours (Harold *et al.*, 1981).

Lipase

The enzyme was extracted with 1.5% NaCl solution from bajra defatted with n-hexane. The same on incubation with olive oil hydrolized the triglycerides releasing fatty acids which were titrated with standard NaOH. The lipase activity was expressed as μm fatty acid released/ min/g Seed (Barron, 1979).

Free fatty acids

The fatty acids in stored bajra grains were extracted in neutral alcohol, titrated with standard NaOH solution and expressed as % oleic acid (Leslie and Harry, 1971).

Peroxide value

Oil was extracted with chloroform : methanol (2:1 V/V) mixture, purified by washing with saturated KCL solution and taken up in chloroform. Peroxides in this oil extract was determined by the reaction between potassium iodide and the oxygen in the peroxides, the liberated iodine being titrated with standard sodium thiosulphate (Harold *et al.*, 1981).

Malondialdehyde

The oil extracted from bajra grains (as described in case of peroxide estimation) is treated directly with thiobarbiturate reagent (Fleisher and Packer, 1978) and the amount of malondialdehyde calculated from the absorbance of the red coloured solution at 535 nm.

Fatty acid composition

The mixed fatty acid profile of bajra grain lipids was measured in grain samples crushed and directly methylated with sodium methoxide and boron trifluoride (Mehta & Lodha, 1979). The free fatty acids extracted in 80% alcohol were methylated with 5% sulphuric acid in methanol (Christie, 1982). The methylated fatty acid esters were separated and detected in a Gas Liquid Chromatograph using a column containing 10% poly DEGS in chromo sorb P (60-80 mesh). Temperature of the column was maintained at 180°C. Injection port and the flame ionization detector unit were maintained at 240°C.

RESULTS AND DISCUSSION

Higher temperature and humidity of the environment may result in higher moisture uptake by the grain which then may deteriorate faster due to increased metabolism and degradative activities. The moisture content of the grain (Table 1) at the start of the experiment was 13.26% which is higher than the safe limit of 9% recommended by Kirk (Kirk *et al.*, 1949) for long term storage of cereal grains. The moisture content fell continuously during storage, the decrease being greater between 0-4 and 8-12 months under both conditions of treatment. The lipase activity in the grains was highest at the beginning and decreased with time of storage (Table 1). The fall in lipase activity was greater in grains stored in aluminium tin in the 0-4 month period and at the end of one year the activities were similar under both kinds of storage.

The level of free fatty acids was 0.775% at the beginning (Table 1). This increased significantly from 4 to 8 and 8 to 12 months in grains stored in gunny bags. In contrast, significant increase in free fatty acids occurred in aluminium tins, only between 8 and 12 months. At 8 and 12 months the levels of free fatty acids were significantly lower in bajra grains stored in aluminium tins. Accumulation of free fatty acids in grains during storage has been reported in wheat (Pixton and Hill, 1967), maize (Alexeeva *et al.*, 1983), rice (Sowbhagya and Bhatacharya, 1976) and also in bajra (Pruthi, 1981). Relatively lower production of free fatty

TABLE 1

Changes in grain moisture, lipase activity and lipid breakdown products in bajra grain during storage.

Period of storage (month)	*Moisture %*		*Lipase activiy (µm FA/min/g)*		*Free fatty acids %*		*Peroxide (%) (mEq./kg Fat)*		*Malondialdehyde (mg/kg/fat)*	
	Al. tin	*G.bag*	*Al. tin*	*G.bag*	*Al. tin*	*G.bag*	*Al. tin*	*G. bag*	*Al. tin*	*G.bag*
0	13.26	13.26	24.17	24.17	0.775	0.775	0.97	0.97	0.41	0.41
4	11.98	12.14	17.36	20.00	0.681	0.729	1.92	1.75	3.09	2.68
8	11.70	11.28	15.23	14.09	0.789	1.085	1.98	4.42	2.30	2.56
12	9.22	9.84	9.99	10.13	1.377	1.655	4.33	4.48	0.90	1.12
	S. Em. ±	C. D. at (5%)	S. Em. ±	C. D. at (5%)	S. Em. ±	C. D. at (5%)	S. Em. ±	C. D. at (5%)	S. Em. ±	C. D. at (5%)
Treatment	0.15	NS	0.57	NS	0.054	0.242	0.10	NS	0.11	NS
Period	0.21	0.94	0.81	0.36	0.077	0.345	0.62	2.78	1.15	0.67
Interaction	0.27	NS	1.12	NS	0.046	0.131	0.44	1.25	0.22	0.62

acids in bajra grains stored in aluminium tin suggest that this mode of storage is preferred to storage in gunny bag.

The peroxide value indicates the degree of oxidation of the fatty acids in the grain lipids. These oxidative reactions occur with unsaturated fatty acids such as linoleic and linolenic acids that are present in the bajra lipids. In the present experiment the peroxide content of grain lipids increased under both conditions of storage (Table 1). However the grains in gunny bags developed peroxides earlier i.e., between 4 and 8 months compared to the grains stored in aluminium tin. The trend of changes in peroxide value was similar to that in free fatty acids which suggests the relationship between the two. It may be that the free fatty acids released from glycerides are more susceptible to oxidative reactions than the fatty acids in intact lipids.

The peroxides are known to get further degraded to aldehydes and ketones (Jhon and Steven, 1972). Malondialdehyde (MDA) is one of the characteristic degradation products in these reactions. During storage MDA content increased and then decreased in grains stored in both the containers (Table 1). Between the two types of containers there was no difference in the extent of MDA formation. Caldwell and Grog (1955) reported that malondialdehyde formation increased during storage upto 20 weeks as indicated by the increased thiobargituric acid reaction. The fluctuations in MDA content in bajra grain during storage suggest that malondialdehyde either undergoes further degradation randomly or it gets volatalized.

The mixed fatty acid (MFA) profile gives the average fatty acid composition of all the lipids in the bajra grain. The free fatty acid profile gives the composition of fatty acids released as a result of action of lipase on the lipids. In Table 2 the data of MFA profile in the beginning of storage is given along with the free fatty acid profile at different intervals of storage. Each value is the arithmetic mean of six repli-

TABLE 2

Mixed fatty acid (MDA) and free fatty acid (FFA) composition in bajra grain during storage.

Months after storage		*Fatty acids*				
		$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$
MFA profile at "O" time		19.79	2.24	30.02	45.55	2.90
FFA profile						
0	A	18.72	2.79	29.91	44.88	3.87
	G	18.90	1.70	32.46	44.00	3.25
4	A	19.14	3.79	25.90	42.87	4.27
	G	21.07	3.54	26.31	45.96	3.08
8	A	21.71	1.90	26.68	44.49	5.15
	G	21.91	1.36	28.69	44.79	4.02
12	A	20.71	2.84	25.73	46.51	4.17
	G	20.25	2.72	26.32	46.21	4.25

Values are means of six observations.

A = Aluminium tin; G = Gunny bag

cate samples. Fatty acid composition of bajra reported here is in the same range reported by Jellum and Powell (1971) and Rooney (1978).

There were no appreciable differences between the free fatty acid and mixed fatty acid profiles of bajra at the beginning of the experiment. Subsequently also the free fatty acid profile did not show variation due to long time storage except possibly for the slight decrease in oleic acid ($C_{18:1}$) and increase in linolenic acid ($C_{18:3}$) in later stages. The differential changes in the levels of $C_{18:1}$ and $C_{18:3}$ may be attributed to differences in the nature of acylglycerols hydrolyzed by lipase. However, studies in wheat (Clayton and Morrison, 1977) and in pearl millet flour (Kaced *et al.*, 1984) have shown that the lipolytic action was random.

Present studies suggest that hydrolysis of grain lipids occur during long term storage and that such changes are less when bajra grains are stored in aluminium tins than in gunny bags.

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