

EFFECTS OF DIFFERENT WHOLESALE PACKAGING MATERIALS ON THE SHELF LIFE OF DEHUSKED FOXTAIL MILLET

Abstract: Millets are group of highly variable small seeded grasses widely grown around the world as cereal crops or grains for fodder and human food. The present investigation was carried out to find out the effect of different wholesale packaging material on the shelf-life of dehusked foxtail millet. The foxtail millet was procured at local Raichur market. For wholesale packaging (5 kg) Gunny Bag without Lining, Gunny Bag with Lining, Cloth Bag and Nylon Bag were selected. The dehusked foxtail millet packed in different packaging material was kept for storage and studied for 6 months. Quality analysis and insect infestation were checked regularly at the interval of 1 month. Finally it was concluded that for wholesale packaging Gunny bag with poly ethylene lining was found to be best, based on its improved quality parameters and minimized insect infestation and also to prevent the damages due to insects and nutrient losses.

Keywords: Foxtail millet, physical properties, biological properties and insect infestation

INTRODUCTION

Millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food. Millets are important crops in the semiarid tropics of Asia and Africa (especially in India, Mali, Nigeria and Niger) with 97 % of millet production in developing countries. The crop is favored due to its productivity and short growing season under dry, high temperature conditions.

Millet contains more calories than wheat, probably because of its higher oil content of 4.2% which is 50% polyunsaturated. Millet is rich in B vitamins, potassium, phosphorus, magnesium, iron, zinc, copper and manganese. Its protein content is a little lower than that of wheat as are the essential amino acids, like wheat, lysine is millet's limiting amino acid. However, millet contains enough protein to still be considered a good protein source.

India stands 2nd position in total world production of millet (Deshpande and Poshadri, 2011). In India total production of foxtail millet is 125 MT (2011-12) (www.indexmundi.com). In Karnataka, small millets are cultivated on an area of 1.25 Mha producing 1.54 MT with a productivity of 1230 kg/ha. Nutritional values of foxtail millet

(*Setaria italica*) per 100 g of edible portion contains, water 12.5 g, protein 12.3 g, lipid 4.3 g, carbohydrate 60.1 g, ash 1.2 g, fat 4.3 g, dietary fiber 9.0 g, calcium 3.1 g, minerals 3.3 g, vitamins and thiamine 590 mg. Minor millets are fair sources of protein and are limiting in lysine (Malleshi and Desikachar, 1985).

Scientific attention to the storage of sorghum, and especially millets has been considerably less than that for other cereals. The main reason is that sorghum and millets are regarded as minor grain crops despite their relative importance as food staple in many growing countries. Other traditional storage structures, which can be used to store millet, include sealed storage drum, mud straw bins and earthenware pot and jar. Underground storage of grains such as millet, sorghum and maize has been reported in different countries such as Somalia and Sudan (Kajuna, 2001). Recently it has been reported, 9 % post harvest losses, due to insects and mite infestation worldwide, suggesting a need to make an overall effort to control these post harvest losses. The most conservative estimate for post harvest losses in food grains in India even put at about 10 %, a quantity good enough to feed atleast 60 million people. Therefore considering these problems raised in processed millets and to increase its shelf life, the study conducted to enhancing the shelf life of dehusked foxtail millet with the following objectives:

- To study the Physical and biochemical properties of foxtail millet
- To evaluate the Shelf life of dehusked foxtail millets using different wholesale packaging materials.

MATERIAL AND METHODS

1. Raw Material

The experiment was conducted in the Department of Processing and Food Engineering, College of Agricultural Engineering, Raichur, Karnataka. Raichur is situated on the latitude of 16°15' North, longitude of 77°21' East and at an elevation of 389 meters above mean sea level which is considered as North Eastern Dry Zone of Karnataka.

The raw material such as foxtail millet (variety: H-1) was procured from Raichur local market. Before packaging foxtail millets were cleaned, dried at room temperature (30 ± 2 °C) till it reaches 10 per cent moisture content and dehusked using Millet dehusker and packed in different wholesale packaging (5kg) materials such as Gunny Bag without Lining(GB) Gunny Bag with Lining (GBL), Cloth Bag(CB) and Nylon Bag(NB) and kept for

storage studies for 6 months. Quality analysis (Proximate composition) and insect infestation were checked regularly at the interval of 1 month.

2. Physical properties of foxtail millet

The physical properties of the millets are important in designing particular equipment or determining the behaviour of the product for its handling. The methodology followed for various physical properties of the foxtail millet are discussed hereunder.

Sl. No.	Physical Properties	Method Used
1	Specific gravity	Pycnometer method
2	Angle of repose	Fixed funnel method
3	Coefficient of external friction	Table provided with changeable surfaces
4	Coefficient of internal friction	Table provided with changeable surfaces
5	Bulk density	Kettle method
6	True density	Displacement Method

3. Proximate Composition of foxtail millet

The proximate composition *viz.*, moisture content, crude fibre, crude fat, total ash/mineral content, crude protein and carbohydrates of foxtail millet were estimated by following the standard methods

Sl. No.	Chemical properties	Method used
1.	Moisture Content	Hot air oven method
2.	Crude Fibre	Sequential acid and alkali hydrolysis method (AOAC, 2005) using Fibra-Plus apparatus
3.	Crude Fat	Soxhlet extraction method (AOAC, 2005) using SOCS – PLUS apparatus
4.	Total Ash	Muffle furnace method
5.	Crude Protein	Micro Kjeltec distillation unit (AOAC, 2005)
6.	Carbohydrates	Anthrone method

4. Insect infestation of foxtail millet

Weeviled and germ eaten grain counting method

79 Grain sample of 50 g was taken, from which a 100 number of grains were drawn
80 randomly. Weeviled grains and germ eaten grains were separated from the sample and are
81 counted to determine the percent mass loss using following formula.

$$82 \quad \text{Mass loss (\%)} = \frac{(W+G)-100}{S(W_1+G_1)} \times 100$$

83 where,

84 W = Percentage by number of weeviled grains

85 G = Percentage by number of germ eaten grains

86 W_1 = Mass of W grains (in grains)

87 G_1 = Mass of G grains (in grams)

88 S = Mass of 100 healthy grains

89 This method lays stress on the nature of the damage so distinction has to be made
90 between weeviled and germ eaten grains among the damaged grains due to insect pests. This
91 method first involves the separate set of hundred counting of two types of damaged grains
92 and then again counting a separate set of hundred healthy grains for ultimately arriving at
93 mass loss due to insects pests. This method hence is preferred where pest complex causing
94 the different nature of damages is causing infestation to the grains. However, mass loss due to
95 weeviled grains and germ eaten grains cannot be estimated separately by this method.

96

97 **RESULT AND DISCUSSION**

98 This chapter deals with the results obtained for various physical and biochemical properties of
99 dehusked foxtail millet and it also includes the results of various experiments conducted to investigate
100 the effect of different wholesale packaging materials on shelf-life of dehusked foxtail millet.

101 **1. Physical properties of dehusked foxtail millet**

102 The mean values of physical properties of unhusked and dehusked foxtail millet viz.,
103 Particle density, Bulk density, Angle of repose, Coefficient of internal friction, Coefficient of
104 external friction, Length, Breadth, Thickness, size and Sphericity were determined using
105 different standard methods. The data obtained for physical properties of unhusked and
106 dehusked foxtail millet are presented in, Table 1 it is inferred that the average Particle density
107 of 1.34 g/cc, Bulk density of 0.87 g/cc, Angle of repose of 27.26°, Coefficient of internal
108 friction of 0.34, Coefficient of external friction of 0.27, Length of 2.02 mm, Breadth of 1.28
109 mm, Thickness of 1.12 mm, size of 1.43 mm and Sphericity of 70.78 % was recorded for
110 dehusked foxtail millet. It was also observed that the average Particle density of 1.26 g/cc,

Bulk density of 0.77 g/cc, Angle of repose of 27.03°, Coefficient of internal friction of 0.48, Coefficient of external friction of 0.40, Length of 2.16 mm, Breadth of 1.31 mm, Thickness of 1.31 mm, size of 1.49 mm and Sphercity of 68.60 % was also recorded for unhusked foxtail millet. A similar finding was reported by Subramanian and Viswanathan (2007)

Table 1: Physical properties of dehusked foxtail millet

Sl. No.	Physical property	Unhusked foxtail millet	Dehusked Foxtail millet
1	Particle density	1.26 g/cc	1.34 g/cc
2	Bulk density	0.77 g/cc	0.87 g/cc
3	Angle of repose	27.03 ⁰	27.26 ⁰
4	Coefficient of internal friction	0.48	0.34
5	Coefficient of external friction	0.40	0.27
6	Length	2.16 mm	2.02 mm
7	Breadth	1.31 mm	1.28 mm
8	Thickness	1.31 mm	1.12 mm
9	Size	1.49 mm	1.43 mm
10	Sphercity	68.60 %	70.78 %

2. Biochemical properties of dehusked foxtail millet

The mean values of biochemical properties of unhusked and dehusked foxtail millet viz., moisture content (% wb), moisture content (% db), protein content (% db), fat content (% db), ash content (% db), fibre content (% db), carbohydrate content and insect infestation were determined using different standard methods. The data obtained for biochemical properties of unhusked and dehusked foxtail millet are presented in, Table 2, it is inferred that the average moisture content on wb) of (9.35 %), moisture content (on db) of (10.31 %), protein content of (13.44 %), fat content of (5.37 %), ash content of (1.53 %), fibre content of (4.76 %) and carbohydrate content of (64.90 %) were recorded for dehusked foxtail millet. It was also inferred that average moisture content (on wb) of (9.46 %), moisture content (on db) of (10.45 %), protein content of (12.86 %), fat content of (4.20 %), ash content of (3.20 %), fibre content of (6.68 %) and carbohydrate content of (63.18 %) were recorded for unhusked foxtail millet.

Table 2: Biochemical properties of dehusked foxtail millet

sl.no	Biological property	Unhusked foxtail millet (%)	Dehusked Foxtail millet (%)
1	Moisture content(%wb)	9.46	9.35
2	Moisture content(% db)	10.45	10.31
3	Protein	12.86	13.80
4	Fat	4.2	5.68
5	Ash	3.2	1.64
6	Fibre	6.68	4.76
7	Carbohydrates	63.18	64.77

3. Moisture content of dehusked foxtail millet in different wholesale packaging materials (% wet basis)

The moisture content of dehusked foxtail millet packed in 4 different wholesale (5 kilo gram) packaging materials and stored at ambient condition for 6 months are recorded and presented in the Table 3. From the table it is seen that moisture content of millet decreased from 9.35 to 6.25 in the case of G.B, 9.35 to 6.72 in case of C.B, 9.35 to 7.47 in case of N.B and 9.35 to 8.05 in the case of G.B.L.

Table 3: Moisture content of dehusked foxtail millet (% wet basis)

Packaging Material	Month						
	0	1	2	3	4	5	6
G.B	9.35	9.25	8.65	8.05	7.45	6.85	6.25
C.B	9.35	9.22	8.72	8.22	7.72	7.22	6.72
N.B	9.35	9.22	8.87	8.52	8.17	7.82	7.47
G.B.L	9.35	9.30	9.05	8.80	8.55	8.30	8.05

4. Protein content of dehusked foxtail millet stored in different wholesale packaging materials(% db)

The effect of storage on protein content of dehusked foxtail millet stored in different packaging material is shown in the Table 4. Irrespective of type of packages, generally there was a marginal decrease in protein content of millets after 6 months of storage. The range of reduction in protein content was from 13.80 % to 12.91 % in G.B, 13.80 % to 13.02 % in C.B, 13.80% to 13.12% in N.B and 13.80% to 13.18% in G.B.L.

Table 4: Protein content of dehusked foxtail millet (% db)

Packaging Material	Month						
	0	1	2	3	4	5	6
G.B	13.8	13.72	13.56	13.38	13.24	13.12	12.91

C.B	13.8	13.74	13.60	13.45	13.32	13.17	13.02
N.B	13.8	13.75	13.63	13.54	13.39	13.28	13.12
G.B.L	13.8	13.76	13.66	13.54	13.46	13.33	13.18

5. Fat content of dehusked foxtail millet in different wholesale packaging materials(% db)

The effect of storage on Fat content of dehusked foxtail millet stored in different packages is shown in the Table 5. Irrespective of type of packages, generally there was a marginal decrease in Fat content of millets after 6 months of storage. The range of reduction in Fat content was from 5.68% to 4.92% in G.B, 5.68% to 4.96% in C.B, 5.68% to 5.20% in N.B and 5.68% to 5.21% in G.B.L.

Table 5: Fat content of dehusked foxtail millet (% db)

Packaging Material	Month						
	0	1	2	3	4	5	6
G.B	5.68	5.42	5.32	5.22	5.12	5.02	4.92
C.B	5.68	5.42	5.33	5.24	5.15	5.06	4.96
N.B	5.68	5.50	5.42	5.34	5.26	5.18	5.20
G.B.L	5.68	5.56	5.49	5.43	5.36	5.28	5.21

6. Ash content of dehusked foxtail millet in different wholesale packaging materials (% db)

The effect of storage on ash content on dehusked foxtail millet stored in different packaging material is shown in the Table 6. From the table it is revealed that there was a marginal increase in ash content of millets after 6 months of storage irrespective of type of packaging material. The range of increase in ash content was from 1.64 % to 1.91 % in G.B, 1.64 % to 1.91 % in C.B, 1.64 % to 1.92 % in N.B and 1.64 % to 1.89 % in G.B.L.

Table 6: Ash content of dehusked foxtail millet (% db)

Packaging Material	Month						
	0	1	2	3	4	5	6
G.B	1.64	1.68	1.73	1.79	1.83	1.87	1.91
C.B	1.64	1.69	1.73	1.77	1.83	1.89	1.91
N.B	1.64	1.69	1.73	1.77	1.82	1.87	1.92
G.B.L	1.64	1.67	1.71	1.76	1.80	1.84	1.89

7. Fiber content of dehusked foxtail millet in different wholesale packaging materials (% db)

The effect of storage on Fiber content of dehusked foxtail millet stored in different packages is shown in the Table 7. Irrespective of type of packages, generally there was a

marginal decrease in Fibre content of millets after 6 months of storage. The range of reduction in Fiber content was from 4.76% to 4.08% in G.B, 4.76% to 4.03% in C.B, 4.76% to 4.08% in N.B and 4.76% to 4.22% in G.B.L.

Table 7: Fibre content of dehusked foxtail millet (% db)

Packaging Material	Month						
	0	1	2	3	4	5	6
G.B	4.76	4.69	4.57	4.45	4.33	4.20	4.08
C.B	4.76	4.58	4.47	4.35	4.25	4.14	4.03
N.B	4.76	4.58	4.48	4.38	4.28	4.18	4.08
G.B.L	4.76	4.67	4.58	4.49	4.40	4.34	4.22

8. Carbohydrate content of dehusked foxtail millet in different wholesale packaging materials (in %)

The effects of storage on Carbohydrate content of dehusked foxtail millet stored in different packages are shown in the Table 8. Irrespective of type of packages, generally there was a marginal increase in Carbohydrate content of millets after 6 months of storage. The range of increase in Carbohydrate content was from 64.77% to 69.93% in G.B, 64.77% to 69.36% in C.B, 64.77% to 68.21% in N.B and 64.77% to 67.45% in G.B.L. These results are in accordance with the results obtained by Vachanth *et al.*, (2010)

Table 8: Carbohydrate content of dehusked foxtail millet (in %)

Packaging Material	Month						
	0	1	2	3	4	5	6
G.B	64.77	65.24	66.17	67.11	68.03	68.94	69.93
C.B	64.77	65.35	66.15	66.97	67.73	68.52	69.36
N.B	64.77	65.26	65.87	66.45	67.08	67.67	68.21
G.B.L	64.77	65.04	65.51	65.98	66.43	66.91	67.45

9. Insect infestation of dehusked foxtail millet in different wholesale packaging materials (in %)

Insect Infestation is the measure of the grain infested by insect. *Triboliumcasteneum* and *Corcyracephalonica* were the insects present in the grain. *Aspergillus* species was the fungi present in the stored grain. Table 9. Shows that G.B.L was the least infected and G.B was the most infected among wholesale packing materials. G.B.L was 4.36 % infected, N.B was 8.79 %, C.B was 9.47 % and G.B was 20.34 % infected during 6 month storage period observed since September.

Table 9: Insect infestation of dehusked foxtail millet (in %)

Packaging Material	Month						
	0	1	2	3	4	5	6
G.B	0	2.65	4.50	8.80	12.46	16.82	20.34
C.B	0	1.70	2.80	4.10	5.65	7.40	9.47
N.B	0	1.45	2.20	3.30	4.55	5.80	8.79
G.B.L	0	0	0	0	0	2.15	4.36

G.B → Gunny Bag without Lining

C.B → Cloth Bag

G.B.L → Gunny Bag with poly ethylene Lining

N.B → Nylon Bag

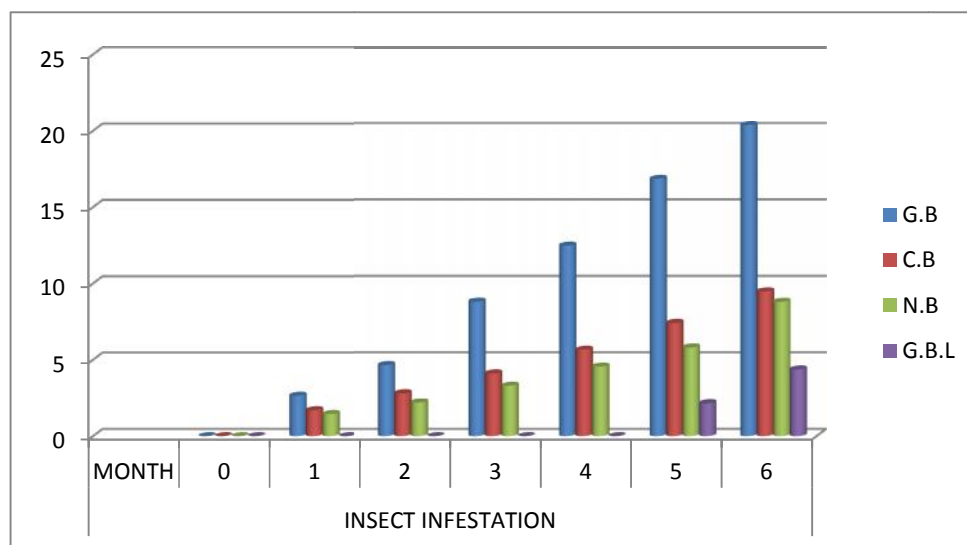


Fig 1: Graphical representation of Insect infestation of dehusked foxtail millet in different wholesale packaging materials

SUMMARY AND CONCLUSION

The present investigation entitled “Studies on enhancing the shelf life of dehusked foxtail millet” was undertaken in the Department of Processing and Food Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur, Karnataka during 2013-14. The results are summarized and the conclusions drawn are presented here under.

Physical properties of dehusked foxtail millet viz., Particle density, Bulk density, Angle of repose, Coefficient of internal friction, Coefficient of external friction, Length,

Breadth, Thickness, size and Sphercicity were found to be 1.34 g/cc , 0.87 g/cc, 27.26°, 0.34, 0.27, 2.02 mm, 1.28 mm, 1.12 mm, 1.43 mm and 70.78 % respectively.

Biochemical properties of dehusked foxtail millet *viz.*, fat, fibre, carbohydrate, ash, protein, moisture content were determined initially to be 5.68 %, 4.76 %, 64.77 %, 1.64 %, 13.80 % and 9.35 %, respectively and there was no insect infestation before storing the commodity.

Four types of packing materials were used for wholesale packaging (5 kg) namely, Gunny bag without lining, Gunny bag with lining, Cloth bag, Nylon bag. The dehusked foxtail millet was stored for 6 months in these packaging materials and observations were taken regularly at the interval of 1 month.

It was observed from biochemical properties that the quality of dehusked foxtail millet packed in Gunny bag with lining was found to be good as compared to other retail packaging materials and also there was lower insect infestation of about 4.36%. The major conclusion drawn from the present investigation is that for wholesale packaging ***Gunny bag with lining*** was found to be best, based on its improved quality parameters and minimized insect infestation and also to prevent the insect infestation and nutrient losses.

LITERATURE CITED

- AOAC, 2005, Official methods of analysis (16th Edition). Association of official analytical chemists, Washington, DC.
- Deshpande, H. W. and Poshadri, A., 2011, Physical and sensory characteristics of extruded snacks prepared from Foxtail millet based composite flours. *Int. Food Res. J.*, **18**: 751- 756.
- Kajuna, T. A. R., 2001, MILLET: Post-harvest Operations. *Sokone University of Agriculture*
- Malleshi, N. G. and Desikachar, H. S. R., 1985, Milling, popping and malting characteristics of some minor millets. *J. Food Sci. Technol.*, **22**: 400-403
- Sahay, K. M. and Singh, K. K., 2010, Unit operations of agricultural processing. 2nd ed. Vikas Publication, 328-331
- Shahidi, F and Chandrasekara, A., 2013, millet grain phenolics and their role in disease risk reduction and health promotion: A review. *J. functional foods*, **5**(2), 570-58.
- Subramanian, S and Viswanathan, R., 2007, Bulk density and friction coefficients of selected minor millet grains and flours. *J. Food Engg.*, **81**, 118–126

251 Vachanth, M. C, Rathinam, K. M, Preethi, R and Loganathan, M., 2010, Controlled atmosphere
252 storage technique for safe storage of processed little millet. *Academic Journal of*
253 *entomology*, **3**(1): 13-16.