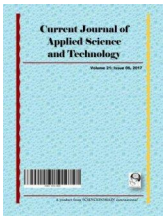

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Effects of Different Wholesale Packaging Materials on the Shelflife of Dehusked Foxtail Millet

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Authors' contributions

This work was carried out in collaboration between all authors. Author PP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PFM and RK managed the analyses of the study. Author VJ managed the literature searches. All authors read and approved the final manuscript.

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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.

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1. 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 [1]. 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 [2].

Scientific attention to the storage of sorghum, and especially millets have 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 [3]. 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 enhance 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.

2. MATERIALS AND METHODS

2.1 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 percent 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.

2.2 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 based on the procedure laid in the handbook of Unit operations of agricultural processing by Singh and Sahay [4], followed procedure discussed here under.

2.3 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 using standard AOAC, 2005, Official methods of analysis (16th Edition) [5] and are discussed below:

Table 1. Methods used to find different physical properties of Dehusked Foxtail millet

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

Table 2. Methods used to find proximate composition of Dehusked Foxtail millet

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

2.4 Insect Infestation of Foxtail Millet

2.4.1 Weeviled and germ eaten grain counting method

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

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

where,

W = Percentage by number of weeviled grains
G = Percentage by number of germ eaten grains
W_1 =Mass of W grains (in grains)
G_1 = Mass of G grains (in grams)
S = Mass of 100 healthy grains

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

3. RESULTS AND DISCUSSION

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

3.1 Physical Properties of Dehusked Foxtail Millet

The mean values of physical properties of unhusked and dehusked foxtail millet *viz.*, Particle density, Bulk density, Angle of repose, Coefficient of internal friction, Coefficient of external friction, Length, Breadth, Thickness, size and Spherecity were determined using different standard methods. The data obtained for physical properties of uhusked and dehusked foxtail millet are presented in, Table 3 it is inferred that the average Particle density of 1.34 g/cc, Bulk density of 0.87 g/cc, Angle of repose of 27.26°, Coefficient of internal friction of 0.34, Coefficient of external friction of 0.27, Length of 2.02 mm, Breadth of 1.28 mm, Thickness of 1.12 mm, size of 1.43 mm and Spherecity of 70.78% was recorded for 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 Spherecity of 68.60% was also recorded for unhusked foxtail millet. A similar finding was reported by Subramanian and Viswanathan [6].

3.2 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 uhusked and dehusked foxtail millet are presented in, Table 4, 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.

3.3 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 5. 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.

3.4 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 6. 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 3. Physical properties of Dehusked Foxtail millet

Sl. no.	Physical property	Unhusked foxtail milllet	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°	27.26°
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	Spherecity	68.60%	70.78%

Table 4. 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

Table 5. 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

Table 6. Protien 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

3.5 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 7. 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.

3.6 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 8. 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.

3.7 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 9. 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.

3.8 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 10. 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 [7].

3.9 Insect Infestation of Dehusked Foxtail Millet in Different Wholesale Packaging Materials (in %)

Insect Infestation is the measure of the grain infested by insect. *Tribolium casteneum* and *Corcyra cephalonica* were the insects present in the grain*. Aspergillus* spices were the fungi present in the stored grain. Table 11. 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. Graphical representation of Insect infestation of dehusked foxtail millet in different wholesale packaging materials is represented in Fig. 1.

Table 7. 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

Table 8. 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

Table 9. 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

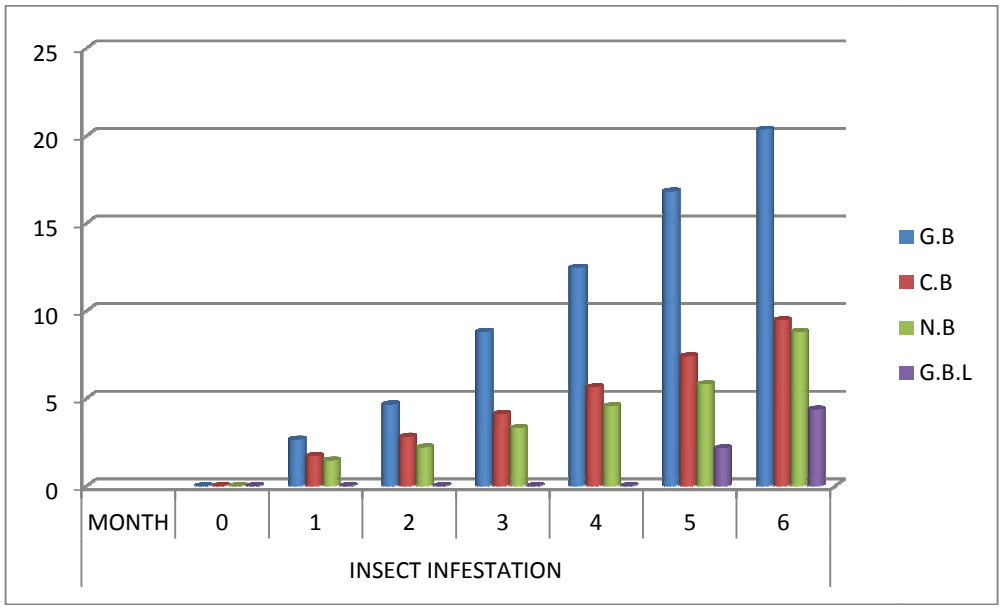

Fig. 1. Graphical representation of Insect infestation of dehusked foxtail millet in different wholesale packaging materials

G.B → Gunny Bag without Lining; C.B → Cloth Bag
G.B.L → Gunny Bag with poly ethylene Lining; N.B → Nylon Bag

Table 10. 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

Table 11. 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

4. 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 hereunder.

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 Sphericity 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Malleshi NG. Desikachar HSR. Milling, popping and malting characteristics of some minor millets. J. Food Sci. Technol. 1985;22:400-403.
2. Deshpande HW, Poshadri A. Physical and sensory characteristics of extruded snacks prepared from Foxtail millet based composite flours. Int. Food Res. J. 2011;18:751-756.
3. Kajuna TAR. MILLET: Post-harvest Operations. Sokone University of Agriculture; 2001.
4. Sahay KM, Singh KK. Unit operations of agricultural processing. 2nd ed. Vikas Publication. 2010;328-331.
5. AOAC. Official methods of analysis (16^{th} Edition). Association of official analytical chemists, Washington, DC; 2005.
6. Subramanian S, Viswanathan R. Bulk density and friction coefficients of selected minor millet grains and flours. J. Food Engg. 2007;81:118–126.

7. Vachanth MC, Rathinam KM, Preethi R, Loganthan M. Controlled atmosphere storage technique for safe storage of processed little millet. Academic Journal of Entomology. 2010;3(1):13-16.

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