International Journal of Food Science and Nutrition
ISSN: 2455-4898; Impact Factor: RJIF 5.14
Received: 01-09-2020; Accepted: 15-09-2020; Published: 02-10-2020
www.foodsciencejournal.com
Volume 5; Issue 5; 2020; Page No. 41-44

Effect of gamma radiation and packaging on storability of *hurda* (tender sorghum)

Mate VN[1], Bakane PH[2], Gupta SV[3], Nagdeve MB[4], Ghorade RB[5], Pardeshi IL[6], Badginwar A[7]
[1-7] Assistant Seed Research Officer, Seed Technology Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Abstract
An attempt was made to enhance shelf life of hurda (tender sorghum) by using gamma radiation source (Co60). *Hurda* (tender sorghum) packed in various thickness viz. 250 and 300 gauge of low density polyethylene (LDPE) (sample size 50 g each) were treated with irradiation doses 1kGy, 1.5 kGy, 2 kGy. Storage stability of samples was observed for samples kept in ambient condition (15-38°C, 19-49 % RH). The quality of the sample was determined with the help of quality parameters, microbiological study and sensory evaluation at the interval of 2 days.
Treatment of gamma irradiation of *hurda* (tender sorghum) significantly affected the quality tests with enhanced the storability. Proximate content such as protein was increased, as increased irradiation doses from 1kGy to 2 kGy. The effect of irradiation as O_2 and Co2 content of *hurda* (tender sorghum) sample packed in various packaging materials were found Non-significant. The bacterial load found less (3.373 x10^3 cfu/g) in 300 gauge packaging treated with 1.5 kGy irradiation dose. *Hurda* (tender sorghum) irradiated with 1.5 kGy and 300 gauge LDPE packaging were retained their green colour up to the 6th day of storage. The sensory evaluation were carried out by the panelists and statistically analyzed. The treated *hurda* (tender sorghum) were found significantly superior to be acceptable up to 6 days at room temperature.

Keywords: *hurda*, gamma-irradiation, shelf life extension, sensory evaluation

1. Introduction

Jowar is the Indian name for sorghum, a cereal grain. Also known as white millet, which can be roasted, steamed, boiled, added to soups and stews or can be ground to flour. Sorghum has nutritional composition similar to or better than rice and wheat in some aspects. The grains contain high fiber and non-starchy polysaccharides and starch with some unique characteristics. There is a considerable variation in sorghum for levels of proteins, lysine, lipids, carbohydrates, fiber, calcium, phosphorus, iron, thiamine and niacin. Protein quality and essential amino acid profile of sorghum is better than many of the cereals and millets. Sorghum in general is rich source of fiber and B-complex vitamins (Chavan *et al.*, 2013) [3]. Protein quality and essential amino acid profile of sorghum is better than many of the cereals and millets. Sorghum in general is rich source of fiber and B-complex vitamins (Gopalan *et al.*, 2000 and Patil *et al.*, 2010) [5, 8].

Hurda is the name given to tender sorghum. *Hurda* (tender sorghum) is one among the special sorghum and it is ready to eats snacks. *Hurda* made from sorghum is known for delicious taste. There is a need for popularize sorghum food as sorghum with its high minerals and fiber content and with low or slow starch digestibility makes an ideal food for diabetic and obese population in the urban as well as rural society.

The consumption of *hurda* has more importance and popular in India since ancient times because of its unique sweet taste. It is generally prepared by roasting over cakes of dried cow dung. Besides, sweet taste *hurda* has some nutritional properties, like good source of dietary fibers, proteins, minerals and carbohydrates. This can be a gluten free diet option for celiac patients. It helps in not only weight loss but also acts as a coolant for the body (Darekar *et al*., 2020) [4].

Hurda (tender sorghum) would be explored, so *hurda* (tender sorghum) can be commercialized same like tender corn which has already entered the global market. *Hurda* (tender sorghum) is neglected despite its nutritive value & therapeutic use. It is one of the underutilized nutritious minor millets. In developing countries, like India with rapid urbanization and changes in social and cultural practices have modified the food habits of the community. The ever increasing market for convenient foods may be tinned, canned, chilled, frozen or preserved presents a whole range of complex operation in food processing. The tender jowar can be very good fast food (Meti *et al.* 2014) [6]. Now a days agro-tourism business is increasing in the rural areas and in the contest of supplying *hurda* (tender sorghum) as a niche product get the more profit to the farmers and producers (Taylor *et al.*, 2006) [9].

The shelf life of *hurda* (tender sorghum) is very short. The time required from growers to end consumers is more. The quality of the fresh *hurda* (tender sorghum) deteriorates during the transportation and sellers storage. Growers, sellers and consumer faced this problem. Food packaging technologies maintain freshness, quality and help a lot in extending shelf life of tender sorghum. The physical shelf life of the packaged product taking into account their fitness for human consumption along with their essential nutrients can be enhanced by means of suitable packaging technologies.

2. Material and methods

2.1 Procurement of Sample

The fresh *hurda* (tender sorghum) sample was procured the local farm near by Aurangabad city, The Var. *Gulbhendi* was plucked directly from the field. The panicles were separated from the stalk and *hurda* were extracted manually. The samples were packed in low density polyethylene (LDPE) pouches of size 125×165 mm of various thicknesses viz. 250, 300 gauge each, heat sealed packets of raw material containing 50 g sample each. The samples were treaded with irradiation doses 1kGy, 1.5 kGy, 2 kGy at Bhaba Atomic Research Centre, Mumbai. These different treated samples were then stored under ambient (15-38 °C, 19-49 % RH). Treated samples with different doses were tested for quality viz., moisture content, microbial load, sensory evaluation, gaseous composition in packets, protein content and reducing sugar at two days of interval.

2.2 Headspace gaseous composition

Package headspace of fresh *hurda* (tender sorghum) was monitored by means of a portable headspace analyzer (Systech Instrument – Model 902D, Dual Trak). The instrument was calibrated with the standard O_2 and CO_2 gases; before the actual observations. The drawn samples were fed simultaneously to the O_2 and CO_2 sensors and concentrations of O_2 and CO_2 were directly read on the digital display panel of the instrument.

2.3 Protein content

Protein was determined by Micro-Kjeldahl method. 0.2 g of sample was digested with concentrated sulphuric acid (H_2SO_4) containing catalyst mixture for 3 - 4 hours. At 70^0C. Then it was distilled with 40 per cent NaOH and liberated ammonia was trapped in 2 per cent boric acid containing methyl red indicator and then it was titrated with 0.01N Hcl. The per cent nitrogen was calculated and protein percentage was estimated in the sample by multiplying with appropriate factor. To calculate protein content %N was determined by given formula (AOAC, 2005).

Normality of H_2SO_4 x Burrete reading x14/100x100
%N =Weight of sample in gm
% Protein = % N X 6.25

2.4 Microbial load

The microbial analysis of *hurda* (tender sorghum) was mainly done for the overall bacterial and fungal count. The microbial analysis was done for ten treatments for ambient storage conditions for quality parameters. On every day after inoculation numbers of colonies developed on the plates were recorded. The colony forming units per gram i.e. CFU/g was calculated for plates yielding bacterial and fungal colonies separately.

$$\mathrm{CFU/g} = \frac{\text{Average Number of Colonies}}{\text{Dilution Factor}}$$

2.5 Sensory assessment

Sensory evaluation was carried out using trained ten panelists at a time after every day as prescribed by (Amerine, 1965). The average scores of all the panelists were computed. The independent sample t test was applied to evaluate *hurda* (tender sorghum) for various organoleptic characteristics. All sensory tests were performed on basis of organoleptical properties such as color, taste/flaour, aroma/smell, appearance and overall acceptability. The data obtained was analyzed statistically by completely randomized design (CRD) as per the procedure given by (Panse and Sukhatome, 1967).

Statistical Analysis: The Three-Way Factorial design was used has three grouping factors (independent variables A-Irradiation dose, B- Thickness of packaging and C- Storage intervals observation) and one observed value (dependent variable). Where A, B, and C are main effects of the three factors. AxB, AxC and BxC are the two way interactions and AxBxC is the three way interaction.

3. Results

3.1 Effect of gamma rays on headspace gaseous composition of *hurda* (tender sorghum) stored under ambient condition

The trend of gaseous composition of stored *hurda* (tender sorghum) is represented in Table 1 and 2. The gaseous (O_2% and CO_2%) composition of treated *hurda* (tender sorghum) samples in different packaging was observed to be ranging from 15.67% to 12.91% for O_2% and 5.614% to 8.0% for CO_2% depending upon various treatments. The O_2 content observed in *hurda* (tender sorghum) sample packed in 300 gauge LDPE was 12.228% with better packed as compared to sample packed in 250 gauge LDPE 15.136 %.

Table 1: Effect of irradiation dose, thickness of packaging material on O_2 (%) of *hurda* (tender sorghum) stored under ambient condition.

Sr. No	Irradiation dose (kGy)	O_2 (%)	LDPE packaging material (gauge)	O_2 (%)	Duration (days)	O_2 (%)
1	Non-irradiated (Control)	13.67	250	15.136	2nd	15.674
2	1	13.55			4th	14.65
3	1.5	13.45	300	12.228	6th	12.93
4	2	13.32			8th	12.913
SE		0.56		0.90		0.56
CD at 5 %		NS		2.628		1.635

Table 2: Effect of irradiation dose, thickness of packaging material on CO_2 (%) of *hurda* (tender sorghum) stored under ambient condition.

Sr. No	Irradiation dose (kGy)	CO_2 (%)	LDPE packaging material (gauge)	CO_2 (%)	Duration (days)	CO_2 (%)
1	Non-irradiated (Control)	6.196	250	6.444	2nd	5.614
2	1	7.045			4th	7.275
3	1.5	7.694	300	7.884	6th	7.741
4	2	7.723			8th	8.000
SE		0.32		0.23		0.32
CD at 5 %		NS		0.671		0.934

3.2 Effect of gamma rays on protein content of *hurda* (tender sorghum) stored under ambient condition

The protein content of fresh sample was recorded 5.49%. The average protein content of treated *hurda* (tender sorghum) samples in different treatment was observed ranging from 5.228 % to 4.92% depending upon various treatments (Table 3). The *hurda* (tender sorghum) sample irradiation with 1.5 kGy was found better in retaining more protein as compared to non-irradiation & irradiation with 1kGy. The *hurda* (tender sorghum) sample packed in 300 gauge LDPE was retained higher protein to the tune of 5.113% as compared to sample packed in 250 gauge LDPE (5.086 %).

Table 3: Effect of irradiation dose, thickness of packaging material on protein content of *hurda* (tender sorghum) stored under ambient condition.

Sr. No	Irradiation dose (kGy)	Protein content (%)	LDPE packaging material (gauge)	Protein content (%)	Duration (days)	Protein content (%)
1	Non-irradiated (Control)	5.031	250	5.086	2^{nd}	5.221
2	1	5.091			4^{th}	5.17
3	1.5	5.228	300	5.113	6^{th}	5.14
4	2	5.225			8^{th}	4.92
SE		0.0481		0.001		0.0481
CD at 5 %		NS		0.004		0.14

3.3 Effect of irradiation dose, thickness of packaging material on microbial load of *hurda* (tender sorghum) stored under ambient condition

Microbial load of *hurda* (tender sorghum) samples increased with storage period under both storage conditions. The results were obtained as colony forming unit per gram of sample (cfu/g) is presented in Table 4 and 5. The irradiation dose of 2 kGy recorded less bacterial load as than other irradiation doses. The bacterial load found less (3.373 x10^3 cfu/g) in 300 gauge packaging as compared to 250 gauge packaging (4.162 x10^3 cfu/g).

The fungal load was recorded less in 2 kGy irradiation dose. The fungal load found less (2.527 x10^3 cfu/g) in 300 gauge packaging as compared to 250 gauge packaging (2.817 x10^3 cfu/g).

Table 4: Effect of irradiation dose, thickness of packaging material on bacterial load of *hurda* (tender sorghum) stored under ambient condition.

Sr. No	Irradiation dose (kGy)	bacterial load x 10^6 (cfu/g)	LDPE packaging material (gauge)	bacterial load x 10^6 (cfu/g)	Duration (days)	bacterial load x 10^6 (cfu/g)
1	Non-irradiated (Control)	5.755	250	4.162	2^{nd}	--
2	1	4.702			4^{th}	1.235
3	1.5	2.550	300	3.373	6^{th}	2.458
4	2	2.064			8^{th}	50.77
SE		0.002667		0.0018		0.0018
CD at 5 %		0.005656		0.0039		0.0039

Table 5: Effect of irradiation dose, thickness of packaging material on fungal load of *hurda* (tender sorghum) stored under ambient condition.

Sr. No	Irradiation dose (kGy)	fungal load x 10^6 (cfu/g)	LDPE packaging material (gauge)	fungal load x 10^6(cfu/g)	Duration (days)	fungal load x 10^6(cfu/g)
1	Non-irradiated (Control)	3.487	250	2.817	2^{nd}	--
2	1	3.248			4^{th}	1.116
3	1.5	2.687	300	2.527	6^{th}	2.124
4	2	1.266			8^{th}	52.20
SE		0.005317		0.003759		0.003759
CD at 5 %		0.011273		0.007971		0.7971

3.4 Effect of gamma rays on sensory evaluation of *hurda* (tender sorghum) stored under ambient condition

The stored sample was tested for overall acceptability in the market from consumer point of view. The panel judges evaluated the flavor, color, taste and overall acceptability of the stored experimental samples. As the time follows up, the score rating observed for all samples stored, followed a declining pattern, but sensory score increased as increase in irradiation dose and maximum at 1.5 kGy. The sensory score for *hurda* (tender sorghum) packed in 300 gauge LDPE was significantly superior over *hurda* (tender sorghum) packed in 250 gauge. The sensory score were reduced as the duration of storage increased up to 4^{th} day and at par on 6^{th} day. But considerable microbiological damage can be observed. The sensory score at 6^{th} day found to be 7.478 was acceptable for storage of *hurda* (tender sorghum) and on 8^{th} day the samples were spoiled, so could not possible to accomplished sensory evaluation.

Table 6: Effect of irradiation dose, thickness of packaging material on sensory score of *hurda* (tender sorghum) stored under ambient condition.

Sr. No	Irradiation dose (kGy)	Sensory score	LDPE packaging material (gauge)	Sensory score	Duration (days)	Sensory score
1	Non-irradiated (Control)	4.663	250	5.206	2nd	7.823
2	1	5.250			4th	7.518
3	1.5	6.038	300	5.381	6th	7.478
4	2	5.225			8th	0
SE		0.150		0.031		0.150
CD at 5 %		0.438		0.0905		0.438

4. Discussion

The effect of O_2 and CO_2 content was found not significant for the both packaging materials. The irradiation dose of 1.5 kGy was found superior as compared to other doses. The packaging material LDPE 300 gauge was found significant as compared to sample packed in 250 gauge.

The overall effect of irradiation was found non-significant on protein content. It is clearly recorded that protein content was found reduced as the duration of storage increased. The packaging material LDPE 300 gauge preserved higher protein. The reduction in the protein content might be attributed to oxidation of the amino acids, increase in the respiratory activity and moisture content as a result of deterioration process of the stored seeds (Veraja *et al.,* 2015) [10].

The bacterial load decreased with increased in irradiation dose significantly. The microbial load of *hurda* (tender sorghum) samples increased during the storage time of all packaged samples. The microbial load showed significant differences as storage time increased. This could be due to the heat of respiration in the packaging material at the early period of storage. So as per the microbial guideline storage of *hurda* (tender sorghum) was found satisfactory for consumption up to 6th day of storage and on 8th day bacterial load found unsatisfactory for consumption. Among the different packaging material LDPE 300 gauge was found to be suitable for storage of *hurda* (tender sorghum) due to less microbial and fungal growth in it during storage.

The sensory attributes were scored by the panel members. All the sensory attributes were changed as the duration increased for irradiation doses and packaging materials. Further, taste and flavour are another important characteristic reported to be significantly highest in LDPE 300 gauge, may be attributed to least gas transfer permeability. The *hurda* (tender sorghum) were organoleptically acceptable upto 6th day duration period. Hedonic rating scale revealed that all the LDPE 300 gauge packaging material was found superior for storage upto 6th days only.

5. Conclusion

The *hurda* (tender sorghum) sample treated with 1.5 kGy gamma irradiation was found to have shelf life upto 6 days. The samples packed in 300 gauge LDPE has been found to be superior in preserving the all quality attributes. Despite the fact that irradiation treatment facility is not easily available this technique has been successful in enhancing the shelf life.

6. Acknowledgement

Authors are thankful to ICAR-AICRP on Post-Harvest Engineering and Technology, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola, 444104, Maharashtra, India and would like to say thanks and greatly acknowledged to Dr. Ashok Badginwar, Senior Scientist, Nuclear Agriculture and Biotechnology Division (NABTD), BARC, Trombey, Mumbai.

7. References

1. Amerine MA, Pangborn RM, Ruessier EB. principles of sensory evaluation of food. Academic Press, New York, 1965.
2. AOAC. Official Methods of Analysis, Association of official Analytical Chemistry, 16th ed. Washington DC, U.S.A, 2005.
3. Chavan UD, Dalvi US, Pawar GH, Shinde MS. Selection of genotype and development of technology for sorghum *hurda* production. International Food Research Journal. 2013; 20(3):1379-1382.
4. Darekar Nilima, Anita Chorey, More WV, Paslawar AN, Parlawar ND, Sawadhkar SM. Productivity and Quality Dynamics of *Parching* Sorghum Genotypes as Influenced by Nitrogen Management through Vermicompost during *Rabi* Season. International Journal of Current Microbiology and Applied Sciences. 2020; 9(2):2956-2964.
5. Gopalan C, Sastry BV and Balsubramanyam SC. Nutritive Value of Indian Foods. National Institute of Nutrition. I.C.M.R., Hyderabad, 2000.
6. Meti Renuka, Ambarish Sindagi and Bujurke AG. Storage quality and sensory evaluation of *tender* sorghum *bicolor (l.,) moench*. International Journal of Biological Research. 2014; 2(3):1-7.
7. Panse, V.S. and Sukhatme, P.V. Statistical Methods for Agricultural Workers. Indian Council Agricultural Research, New Delhi, 1967, 347.
8. Patil PB, Sajjanar GM, Biradar BD, Patil HB, Devarnavadagi SB. Technology of *hurda* production by microwave oven. Journal of Dairying, Foods and Home Sciences. 2010; 29:232-236.
9. Taylor JRN, Schober TJ, Bean SR. Novel food and non-food uses for sorghum and millets. Journal of Cereal Science. 2006; 44:252-271.
10. Veraja P, Rai PK. Effect of polymer coating, chemicals and bio control agent on storability of black gram (*Vigna mungo* L.). International Journal of Plant & Soil Science. 2015; 8(6):1-8.