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ASSESSMENT OF FUNCTIONAL QUALITY CHANGES IN WATER CHESTNUT ENRICHED FLAXSEED NUTRITIONAL LADDU DURING STORAGE

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Abstract

The present investigation was conducted to assess functional qualities of water chestnut enriched flaxseed nutritional laddu. The quality evaluation of the nutritional laddu was done up to 20 days of storage. These laddu contained appreciable amounts of crude protein (24.22%), crude fat (28.25%), crude fibre (9.95%) and total ash (4.86%). All of these decreased during storage periods in all the treatments. The maximum L* value (53.133) was found in T_6 (20% Flaxseed + 30% Water chestnut + 45% Jaggery + 3% Ginger + 2% Dry fruit) at 20 days and minimum (38.170) in T_0 (50% Flaxseed + 45% Jaggery + 3% Ginger + 2% Dry fruit) at 0 day of storage period. The highest total ash was found in T_6 (5.530) at 0 day and lowest in T_0 (3.100) at 20 days. It was concluded that up to 30 % water chestnut can be incorporated in flaxseed laddu to obtain best overall acceptability.

Introduction

Flaxseed a cool-temperature annual herb of the family Lineaceae and genus Linum, flaxseed (*Linum usitatissimum* L.), is also use known instead of referred to as Alsi in Indian. The texture and flavour of flaxseed are crunchy and nutty. Due to its numerous benefits for human health, more people are using flaxseed as a nutritional supplement (Yadav *et al.* 2018). Flaxseed is a leading source of omega-3 fatty acids, fibre, protein, amino acids, vitamin E, and lignins. Which provides essential requirements for human nutrition. Additionally, flaxseed offers healthful qualities that guard against diseases including menopausal issues, cardiovascular disease, and many others (Chishty *et al.* 2016).

In India, Singhara is a common name for water chestnut (*Trapa natans* var. *bispinosa* Roxb). Indian water chestnut is a floating-leaved aquatic plant that grows yearly in tempera.te and tropical freshwater wetlands, rivers, lakes, ponds, and estuaries (Takano and Kadono 2005). Water chestnut flour contains high levels of protein (6.9%), essential amino acids (4-7%), dietary fibre (4-10%), carbohydrates (50-60%), and very little fat (2-4%). It also contains phosphorus, magnesium, vitamins B and E, and potassium (Sacchetti *et al.* 2004). While, the majority of gluten-free products are deficient in vitamin B, iron, foliate, and dietary fibre (Moroni *et al*. 2009). Due to the absence of gluten in water chestnut fruit, its flour can be used in place of wheat flour when making items that are gluten-free and water chestnut supplies may partially replace wheat given their cereal basis (Demirkesen *et al*. 2010).

Material and Methods

The raw materials like Flaxseed, Water chestnut flour, Ginger powder, Almond, jaggery and other ingredients required were procured from the local market of Banda. The procured flaxseeds were cleaned and roasted for 12 minutes in hindalium pan at simmering flame till it became crispy

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and dark brown in color. The roasted flaxseeds were then grinded into powder using mixer grinder for 2 minutes. The flaxseeds powder was stored in air tight plastic containers at room temperature.

All ingredients such as jaggery, water chestnut powder, and ginger powder were mixed uniformly with flaxseed powder. Took a bowl of jaggery and 50 ml of water and boil for 8 minutes till the syrup reached at soft ball stage (112 -115^{0}C). After that ghee and dry fruit were added into jaggery syrup. Finally, different treatment formulations (Table 1) of laddus were made manually and packed in transparent plastic containers and stored for quality analysis at room temperature for 20 days.

Table 1. Formulation of nutritional laddu with different level of flaxseed and water chestnut.

Ingredients	T_0	T_1	T_2	T_3	T_4	T_5	T_6
Flaxseed (g)	50	45	40	35	30	25	20
Water chestnut (g)	00	5	10	15	20	25	30
Jaggery (g)	45	45	45	45	45	45	45
Ginger powder (g)	3	3	3	3	3	3	3
Dry fruit (g)	2	2	2	2	2	2	2

T= Treatment.

The colour was determined as per the method with slight modification given by Jambamma (2011) using Hunter Lab Color Flex meter. Results are expressed as 'L*' value an indicator lightness and darkness that varies from 0 to 100, where 100 is for perfect white and 0 for black. The 'a*' value an indicates of redness when it is positive, green when negative and grey when it is zero. The b*' value an indicator of yellowness of the sample when positive, blueness when negative and grey when zero.

Raw materials such as like flaxseed and water chestnut of nutritional laddu were chemical analysis of nutritional laddu was conducted for moisture, total ash, crude protein, crude fiber and crude fat of the samples was determined using the procedure of AOAC (2005).

Results and Discussion

The data in respect to change in color L*, a*, b*, value during storage is presented in Table 2 showed that the L* was significantly affected nutritional laddu and greatest L* mean notice in T_6 (51.603). L* was also significantly affected from storage period. The maximum value of L* was found (46.608) at 20 days however minimum (42.673) at 0 days of storage period. The interaction of both was significant on L* value. The maximum L* value was found in T_6 (53.133) at 20 days and the minimum in T_0 (38.170) at 0 days of storage period. The highest value of a* was found (8.383) at 0 day however minimum (6.624) at 20 days of storage period. The interaction of both was significant on a* value. The maximum a* was found in T_2 (9.177) at 0 day and minimum in T_6 (5.800) at 20 days of storage period and the maximum b* was found in T_6 (16.493) and minimum in T_0 (15.230). The highest value of b* was found (16.394) at 0 day however minimum (15.735) at 20 days of storage period. The interaction of both was significant on b*. The maximum b* was found in T_6 (17.120) at 0 day and minimum in T_0 (15.183) at 20 days of storage period. The decreases in a* and b* value may be attributed to the darkening of laddu color due to the degradation of with a nine present in ashwagandha root powder and browning of flaxseed flour. Flaxseeds have a significant effect on color scores i.e., L* (lightness/darkness), a* (redness/greenness) and b* (yellowness/blueness) of various fortified food products. Color values of different flaxseed supplemented products like cookies (Ganorkar and Jain 2014), bars Flaxseed

Table 2. Effect of storage periods on color L*, a*, b* value and moisture of laddu in different treatments.

Treatments	L* value			a* value			b* value			Moisture (%)		
	Storage period (days)			Storage period (days)			Storage period (days)			Storage period (days)		
	0	20	Mean	0	20	Mean	0	20	Mean	0	20	Mean
T_0	38.170	42.507	40.338	8.167	6.727	7.447	15.277	15.183	15.230	7.143	9.133	8.138
T_1	39.077	43.340	41.208	9.157	7.610	8.383	16.283	15.837	16.060	7.467	9.433	8.450
T_2	39.413	44.157	41.785	9.177	7.563	8.370	16.473	15.563	16.018	8.500	9.933	9.217
T_3	41.370	45.150	43.260	7.947	6.717	7.332	16.487	15.383	15.935	8.700	10.480	9.590
T_4	44.107	48.500	46.303	6.607	6.067	6.337	16.547	16.197	16.372	8.827	10.660	9.743
T_5	46.500	49.467	47.983	6.353	5.887	6.120	16.570	16.117	16.343	9.000	10.800	9.900
T_6	50.073	53.133	51.603	6.207	5.800	6.003	17.120	15.867	16.493	9.023	10.833	9.928
Mean	42.673	46.608	---	8.383	6.624	---	16.394	15.735	---	8.380	10.182	---
	(T)	(S)	(TXS)	(T)	(S)	(TXS)	(T)	(S)	(TXS)	(T)	(S)	(TXS)
CD (0.05)	0.417	0.223	0.590	0.371	0.198	0.524	0.342	0.183	0.484	0.274	0.146	NS
SE(m) ±	0.143	0.077	0.203	0.127	0.068	0.180	0.118	0.063	0.166	0.094	0.050	0.133

T = Treatment, S = Storage, TxS = Interaction and NS = Non-significant.

Table 3. Effect of storage periods on Total ash, Crude protein, Crude fiber and Crude fat of laddu in different treatments.

Treatments	Total ash (%)			Crude protein (%)			Crude fiber (%)			Crude fat (%)		
	Storage period (days)			Storage period (days)			Storage period (days)			Storage period (days)		
	0	20	Mean	0	20	Mean	0	20	Mean	0	20	Mean
T_0	3.467	3.100	3.283	16.253	16.150	16.202	10.653	10.523	10.588	27.500	27.250	27.375
T_1	3.500	3.137	3.318	17.253	17.090	17.172	9.953	9.800	9.877	27.753	27.550	27.652
T_2	3.440	2.943	3.192	17.843	17.200	17.522	9.653	9.463	9.558	26.533	26.247	26.390
T_3	4.560	3.310	3.935	18.493	18.330	18.412	9.543	9.133	9.338	25.750	25.500	25.625
T_4	4.703	4.470	4.587	18.800	18.373	18.587	9.033	8.900	8.967	24.500	24.257	24.378
T_5	4.953	4.783	4.868	19.903	19.500	19.702	8.643	8.600	8.622	23.750	23.543	23.647
T_6	5.530	5.470	5.500	20.090	19.717	19.903	8.257	7.833	8.045	22.500	22.237	22.368
Mean	4.308	3.888	---	18.377	18.051		9.391	9.179	---	25.470	25.226	---
	(T)	(S)	(TXS)	(T)	(S)	(TXS)	(T)	(S)	(TXS)	(T)	(S)	(TXS)
CD (0.05)	0.701	0.375	NS	0.047	0.025	0.192	0.147	0.079	NS	0.530	NS	NS
SE(m) ±	0.241	0.129	0.341	0.136	0.072	0.066	0.051	0.027	0.027	0.182	0.097	0.257

T = Treatment, S = Storage, TxS = Interaction and NS = Non-significant.

addition decreased lightness and increased redness of bars. Increased flaxseed flour level in cookies led to considerably darker and browner appearance of cookies possibly due to Maillard browning reactions during cooking of flaxseed flour (Khouryieh and Aramouni 2012).

The Moisture content of nutritional laddu in different combination has been presented in (Table 2). The maximum mean of moisture was found in T_6 (9.928) and followed by T_5 (9.900) while minimum value in T_0 (8.138). Moisture was also non-significantly affected by storage period. The highest value (10.182) at 20 days but lowest (8.380) at 0 days was recorded. The reason for increases in instead of moisture content with storage period may be attributed to the effect of hygroscopic nature of product. Similar findings have been reported by Sharma *et al.* (2019) in rice bean flour based Ladoo, and Pathania *et al.* (2013) during their study on effect of moisture and packaging on the shelf life of wheat flour.

The total ash was non- significant effect of various treatments on nutritional laddu show that the (Table 3). The highest value of total ash was notice in T_6 (5.50). Total ash decreases by storage period. The interaction of treatment and storage period was found non-significant in total ash. The highest total ash was found in T_6 (5.530) at 0 days and lowest in T_0 (3.100) at 20 days. The total ash content was decreased during storage period. Similar decrease in ash content during 60 days of storage was reported by Butt *et al.* (2004), while studying the effect of moisture and packaging and shelf-life of wheat flour.

`Crude protein content varied in various treatments (T_0 to T_6) and decreased during storage periods. The results of Table 3 show that the at 0 days highest protein was found in T_6 (20.090) but lowest in T_0 (16.150) at 20 days of nutritional laddu. The decrease in protein content of the product during storage might be due to accelerate the proteolytic activity and similar results have been reported by (Leelavati *et al*. 1984).

Crude fibre content varied with different treatment combinations of flaxseed and water chestnut in various treatments from T_0 to T_6 and also affected with storage (Table 3). At 0 days. The highest crude fibre was found in T_0 (10.653) and lowest in T_6 (7.833) at 20 days of nutritional laddu. The decrease in crude fibre might be due to the degradation of hemicelluloses and other structural polysaccharides during storage. Heat and moisture solubilizers also degrade pectic substances leading to the decrease in crude fibre content as reported by Usha *et al*. (2011) in bread fruit flour.

The crude fat (%) decreased with the increase in quantity of water chestnut in nutritional laddu (Table 3). This may be due to high crude fat (%) in flax seeds as reported by Prajapati *et al.* (2016) in chemical composition of roasted and non-roasted full fat flaxseed (*Linum usitatissimum* L.) flours. A slight decrease in crude fat content might be due to oxidation of fat into free fatty acids during storage as reported by Shukla *et al*. (2013) during storage of basen (Bengal gram flour) burfi.

It can be concluded from above study that up to 30 % water chestnut can be incorporated in linseed laddu to obtain best overall acceptability. The treatment T_6 (20% Flaxseed + 30% Water chest nut + 45% Jaggery + 3% Ginger + 2% Dry fruit) contained appreciable amount of crude protein (24.22%), crude fat (28.25%), crude fibre (9.95%) and total ash (4.86%). It was observed that the Crude protein, Crude fat, crude fibre and Total ash decreased during storage periods. The developed product has high potential for commercialization as having rich nutritional properties along with overall acceptability.

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