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Effect of Guar Flour Supplementation on Quality and Shelf Life of Muffins

Priyanka Sharma, Amarjeet Kaur, Amritpal Kaur
Department of Food Science and Technology P.A.U. Ludhuiana

ABSTRACT
The drought resistant and lesser explored legume, Guar bean (*Cyamopsis tetragonoloba*), was used to prepare muffins with higher protein content. In present study, the muffins were prepared using three varieties of treated guar flour i.e. G 80, Ageta 112, HG 365 at supplementation levels 10, 15 and 5 per cent respectively, for storage studies under different conditions. The moisture content, water activity (a_w), free fatty acids, peroxide value, microbial analysis and sensory evaluation were done at a regular interval of seven days. Moisture content of muffins increased significantly with increase in time of storage under both ambient and refrigerated conditions. Water activity value increased with increase in time period under both the storage conditions. Addition of guar flour to muffin had no effect on the water activity that increased gradually upto 0.83. Guar supplemented muffins showed higher moisture content than control and maximum in G 80 supplemented muffins. Formation of free fatty acids (% oleic acid) and peroxide value increased with increased storage period. The changes in values were more readily pronounced at ambient temperatures. The overall acceptability was maximum for Ageta 112 supplemented muffins however the acceptability reduced with increased storage. The microbial analysis showed that refrigerated muffins were acceptable even at 28th day of storage analysis while the muffins at ambient conditions showed lesser shelf life. Muffins supplemented with HG 365 were spoiled at 21st day of storage analysis under ambient storage conditions.

I. INTRODUCTION

Realising the increasing consumption and high acceptance of bakery products, these offer a significant opportunity of providing and improving the nutrition level among the consumers. Legumes offer a good opportunity for an economic and widely available protein source for human consumption [1,2,3] (Youseff *et al* 1989, Vijayakumari *et al* 1997, Doss *et al* 2011). Legume proteins are rich in lysine but deficient in sulphur-containing amino acids, whereas cereal proteins are deficient in lysine but have adequate levels of sulphur-containing amino acids [4] (Eggum&Beame 1983).The combination of cereal and legume proteins would thus provide a better overall balance of essential amino acids [5][6] (Livingstone *et al* 1993, Hera *et al* 2012). Guar bean (*Cyamopsis tetragonoloba*), the drought resistant legume majorly grown in India, Pakistan, has a status of under explored legume as for direct consumption. Guar bean presently is utilized for guar gum and fodder purpose. Recently its utilization for oil extraction has created another significant level of demand of guar bean in the market. However, it bears a good proportion of protein, fibre and has also proved to hold other health benefits as well. It is known to posses post prandial low glycemic index [7] (Mukhtar et al 2006), also shows lipid-lowering effects [8] (Fabrenbach, 1965). However, the presence of anti nutritional factors in legumes makes treatment of legumes compulsory before its consumption. On the basis of previous research work, the guar bean were autoclaved, in order to reduce its antinutritional factors. The autoclaved guar bean flour was added to cereal based bakery product i.e. muffin with an objective to enhance the nutritional value of muffin and an effort for value addition of guar bean. The present study was carried out to assess the quality and shelf life of guar flour supplemented muffins stored under different set of conditions.

II. MATERIALS AND METHODS

Three varieties of Guar bean (*Cyamopsis tetragonoloba* or *C. psoraloides*) i.e. G 80, Ageta 112 and HG 365 grown in fields of Punjab Agricultural University, Ludhiana were procured from seeds and forage section of the university. The guar seeds were treated, dried, milled and incorporated at various levels to wheat flour for production of muffins. The best levels of guar flour supplementation were selected on base of previous study i.e. autoclaved guar flour from varieties G 80 @ 10 %, Ageta 112 @ 15 % and HG 365 @ 5 %, in the order. The selected formulation of muffins were packed in Linear Low Density Polyethylene (LLDPE) cling wrap and stored under different storage conditions i.e ambient temperature and

refrigerated temperature. The moisture content, water activity, free fatty acid value, peroxide value microbial analyses and sensory evaluation were performed at regular interval of seven days.

2.1. Chemical Analysis of Flour

Quality of stored muffins were analysed using standard procedures. Moisture content was determined by the hot air oven method [9] (AACC, 2000). Water activity of stored Modified flours were estimated using water activity meter (Decagon, Pawkit water activity meter). Standard AOAC procedure [10] (Anon 2001) was followed for free fatty acids determination in Modified flours.

$$\%FFA\ (\%\ oleic\ acid) = \frac{282 \times 0.02N\ KOH \times ml.\ of\ alkali\ used \times Dilution\ factor}{1000 \times wt.\ of\ sample\ taken} \times 100$$

Peroxide value was followed by standard method as per [10]. Microbial analysis for total plate count and yeast and mold count was carried using Standard AACC procedure [9].

2.2. Treatments: Muffins were prepared after incorporation of fibre such as barley, psyllium and oat at levels of 0-6 percent.

2.3. Product Preparation: Muffins were prepared according to standard procedures [9] with slight modifications.

2.4. Sensory Evaluation: Product prepared was evaluated for sensory properties by panel of semi trained judges [11].

2.5. Shelf life

After preparation, the control and fibre enriched muffins were packed in Linear Low density Polyethylene (LLDPE) and were stored for 30 days at ambient (30±1ºC) and refrigerated (4-6ºC) conditions. Periodic analysis for moisture, water activity and free fatty acid were carried out to assess the shelf life.

III. RESULT AND DISCUSSION

Moisture content

Table 19. Effect of storage conditions and period on moisture content (%) of muffins prepared by incorporation of selected levels of autoclaved guar flour and packed in LLDPE

Selected level/ storage period (days)	LLDPE											
	Ambient storage (30±10 ºC)						Refrigerated (4 - 7 ºC)					
	0	7	14	21	28	35	0	7	14	21	28	35
Control	21.25^{a}	21.91^{ab}	23.29^{ab}	25.15^{b}	ND	ND	21.25^{a}	22.12^{a}	25.5^{ab}	27.09^{ab}	28.42^{ab}	29.83^{c}
G 80 (10%)	23.49^{a}	23.51^{a}	24.64^{ab}	25.92^{b}	ND	ND	23.49^{a}	23.3^{ab}	25.02^{ab}	26.5^{ab}	28.24^{b}	28.71^{b}
Ageta 112 (15%)	24.54^{a}	24.71^{a}	26.41^{ab}	27.32^{b}	ND	ND	24.61^{a}	24.55^{ab}	25.87^{abc}	28.4^{bcd}	29.49^{cd}	29.68^{d}
HG 365 (5%)	22.31^{a}	22.40^{a}	23.46^{a}	ND	ND	ND	22.30^{a}	22.54^{a}	23.91^{ab}	26.26^{ab}	29.08^{ab}	30.27^{b}

Table 19 represents the effect of storage conditions and period of storage on moisture content of muffins prepared by incorporation of autoclaved guar flour. Guar incorporated muffins showed higher moisture content than the control because of increase in moisture absorption by guar flour. Moisture content of muffins increased significantly with increase in time of storage under both ambient and refrigerated conditions. The muffins stored under ambient conditions showed a higher rate of moisture gain than those stored under refrigerated conditions. Similar reduction trends were observed by Bhise and Kaur [12] in fibre incorporated stored muffins.

Water activity

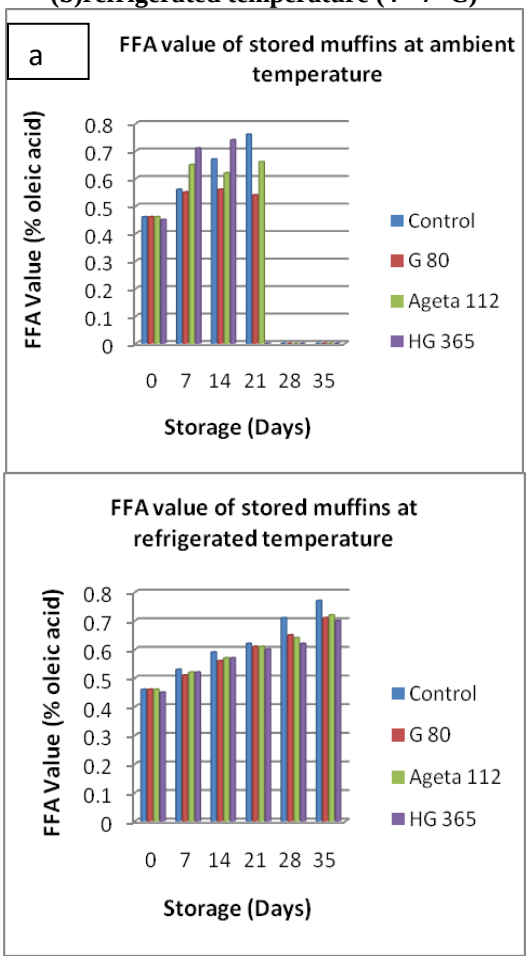
Table 2. Effect of storage condition and period on water activity (a_w) of guar flour supplemented muffins

Variety	Ambient Temperature (30±5 ºC)							Refrigerated Temperature (4 - 7 ºC)					
	0	7	14	21	28	35		0	7	14	21	28	35
Control	0.76	0.77	0.80	0.83	ND	ND		0.76	0.77	0.81	0.82	0.83	0.84
G 80	0.75	0.76	0.79	0.80	ND	ND		0.75	0.77	0.79	0.8	0.81	0.82
Ageta 112	0.74	0.76	0.77	0.81	ND	ND		0.74	0.76	0.77	0.79	0.83	0.83
HG 365	0.75	0.77	0.79	ND	ND	ND		0.75	0.77	0.78	0.81	0.82	0.83
LSD ($p<0.05$)			.02							.02			

Table 2 shows the effect of storage condition on water activity of Guar flour supplemented muffins. An increase in water activity of muffins was observed with increases in storage period. The water requirement for growth of microorganisms was expressed in terms of moisture available or water activity [13].Water activity of control increased from 0.76 at zero day to 0.83 at 21st day of storage. Similar trend was observed by Bhise and Kaur [12] and Ho *et al* [14] for storage of bread. Control showed maximum water activity while the same was seen minimum for Ageta 112 supplemented muffins. Low water activity of Ageta 112 supplemented muffin might be due to higher water binding capacity of Ageta 112 as compared to G 80 and HG 365.

Free fatty acid

Fig. 1 Effect of storage on Free fatty acid (% oleic acid) of guar flour supplemented muffins at (a) ambient temperature (30±5 ^{0}C) and (b)refrigerated temperature (4 - 7 ^{0}C)



The effect of storage condition and period on free fatty acid of guar flour supplemented muffins is presented in Fig 1. Formation of free fatty acids was lower in guar flour supplemented muffins when compared to control. This may be because of the presence of antioxidant property in guar bean [15]. With increase in storage period, an increase in free fatty acid value of flour supplemented muffins was noted in muffins and this trend was common for muffins under both types of storage conditions. This increase in value was noticed higher for the muffins stored at ambient temperature as compared to muffins stored at lower temperatures. Formation of free fatty acids varied significantly with respect to storage condition. Free fatty acid for control sample increased from 0.43 at zero days to 0.73 at 21st days of storage under ambient conditions whereas at refrigerated conditions, increase was up to 0.74 at 35th day of storage. Development of free fatty acids was at slower rate in muffins stored at refrigerated conditions as compared to muffins stored at ambient temperatures. A similar trend was given by Singh *et al* [16] for storage studies of biscuits and Bhise and Kaur [12] for bread storage studies.

Peroxide value

Fig. 2 Effect of storage on Peroxide value (meq/Kg) of guar flour supplemented muffins at (a) ambient temperature (30±5 ^{0}C) and (b)refrigerated temperature (4 - 7 ^{0}C)

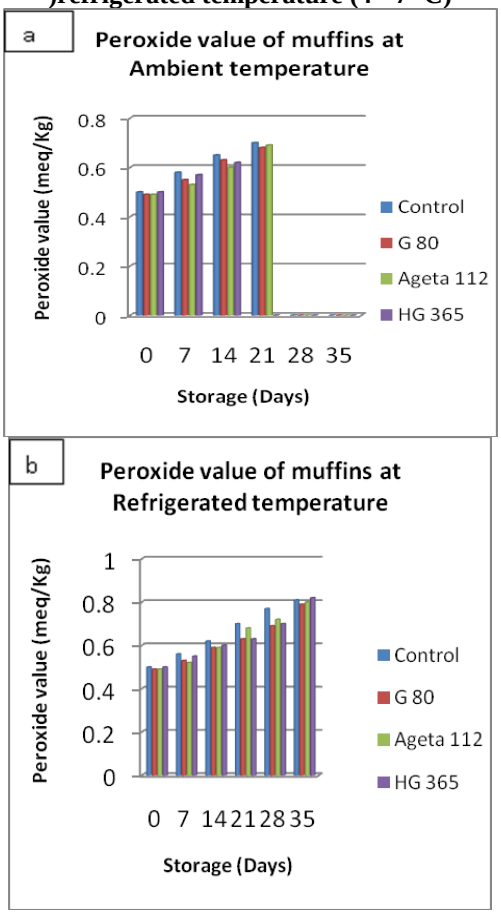


Fig 2 presents the effect of storage conditions on peroxide value (meq/Kg) of guar flour supplemented muffins at ambient temperature (30±5 ^{0}C) and refrigerated temperature (4 - 7 ^{0}C). Control exhibited the highest peroxide value throughout the storage period, showing a high oxidation process. Among all samples, the muffins supplemented with guar flours showed lower peroxide values throughout storage period than control sample. Higher peroxide value indicates auto oxidations of fat present in muffin. Fig 2 suggested that antioxidant properties of guar flour could be responsible for comparatively lower peroxide value in guar flour supplemented muffins as compared to control. Significant variations were found in peroxide value with respect to stotage and conditions and storage period.

Microbial Analysis

4.4.10.5 Effect of storage conditions and period on microbial count of muffins prepared by incorporation of selected levels of autoclaved guar flour and packed in LLDPE

The yeast and mold count of guar flour supplemented muffins stored at ambient and refrigerated temperatures were estimated (Table 21). Statistically significant increase in count was noted during storage period with increased count of yeast and mold. Guar flour supplemented muffins showed lowest count than control which might be attributed to the lower water activity of the former. Further the lower temperature conditions enhanced the shelf life of product by reducing the multiplication rate of microflora at lower temperatures (Frazier 1978). Yeast and mold count varied significantly with respect to storage conditions and storage period. The muffins supplemented with flour from variety HG 365 at ambient temperatures stored became unfit for consumption after 21st day of storage. However, the rest of samples were spoiled due to mold growth after 28th day of storage analysis. Although muffins stored under refrigerated temperatures were suitable for consumption but the overall acceptability was markedly reduced.

Table 21. Effect of storage conditions and period on on Yeast and Mold count (cfu/g X 10^2) of muffins prepared by incorporation of selected levels of autoclaved guar flour and packed in LLDPE

Storage period (days)/ Selected level	LLDPE							
	Ambient Temperature (30±10 °C)				Refrigerated Temperature (4 - 7 °C)			
	Control	G 80 (10%)	Ageta 112 (15%)	HG 365 (5%)	Control	G 80 (10%)	Ageta 112 (15%)	HG 365 (5%)
0	2.9^d	3.1^d	2.8^d	3.1^a	3.2^f	2.7^f	3.0^f	2.5^f
7	4.1^c	3.8^c	3.4^c	4.4^b	4.4^e	3.8^e	3.8^e	3.2^e
14	5.2^b	4.5^b	4.1^b	6.3^c	6.1^d	4.5^d	4.5^d	4.6^d
21	7.6^a	6.8^a	7.1^a	ND	6.8^c	5.0^c	5.7^c	5.4^c
28	ND	ND	ND	ND	7.8^b	6.3^b	6.4^b	6.6^b
35	ND	ND	ND	ND	9.1^a	7.0^a	7.2^a	7.1^a

Total plate count of guar flour supplemented muffins at ambient temperature (30±5^{0}C) and under refrigerated temperature (4 - 7 ^{0}C) is represented in Table 22. Total plate count was found higher in control than the guar flour supplemented muffins. The higher water holding capacity of guar flour lead to reduced water activity, which might contributed to slower bacterial growth in guar flour supplemented muffins. Total plate count varied significantly with respect to storage conditions and period. Muffins stored under ambient temperature showed maximum bacterial count and showed lesser shelf life than the muffins stored under refrigerated temperatures. Highest water holding capacity of variety Ageta 112 could be attributed to the lowest bacterial growth of guar flour supplemented with the same variety.

Table 22. Effect of storage conditions and period on Total plate count (cfu/g X 10^3) of muffins prepared by incorporation of selected levels of autoclaved guar flour and packed in LLDPE

Storage period (days)/ Selected level	LLDPE							
	Ambient Temperature (30±10 °C)				Refrigerated Temperature (4 - 7 °C)			
	Control	G 80 (10%)	Ageta 112 (15%)	HG 365 (5%)	Control	G 80 (10%)	Ageta 112 (15%)	HG 365 (5%)
0	3.2^d	2.6^d	2.7^d	2.8^c	3.0^f	2.6^f	2.0^f	2.7^f
7	4.7^c	3.5^c	3.3^c	4.0^b	4.1^e	3.4^e	3.2^e	3.2^e
14	5.1^b	4.3^b	4.9^b	5.4^a	5.5^d	4.8d	4.0^d	4.0^d
21	7.9^a	8.3^a	6.7^a	ND	6.2^c	5.3c	4.9^c	4.8^c
28	ND	ND	ND	ND	7.0^b	6.0^b	5.2^b	6.0^b
35	ND	ND	ND	ND	8.1^a	6.7^a	6.1^a	7.4^a

4.3.10.6 Effect of storage conditions and period on overall acceptability (maximum score 9.0) of muffins prepared by incorporation of selected levels of autoclaved guar flour and packed in LLDPE

Muffins were cling wrapped in LLDPE sheets and stored under two set of conditions i.e. ambient conditions and refrigerated conditions. The effect of storage condition and period on overall acceptability of guar flour supplemented muffins is presented in Fig. 12. The overall acceptability of muffins stored under ambient conditions was stable upto seven days and then reduced slightly after 14th day. Considerable reduction in overall acceptability was observed at 21st day and became unacceptable thereafter due to microbial spoilage. Variety Ageta 112 incorporated muffins scored highest overall acceptability (6.0) after 28th day of storage. Further, storage of product lead to microbial spoilage. HG 365 incorporated muffins showed least acceptability and became unacceptable after 21 days of storage. Acceptability of muffins under refrigerated conditions was higher and for longer period. Refrigerated muffins were consumable also at 35th of storage. Highest acceptability was observed for muffins with Ageta 112 incorporated muffins, followed by muffins incorporated with G 80 and HG 365 (5.4) and control. However, the acceptability of muffins lowered with storage period.

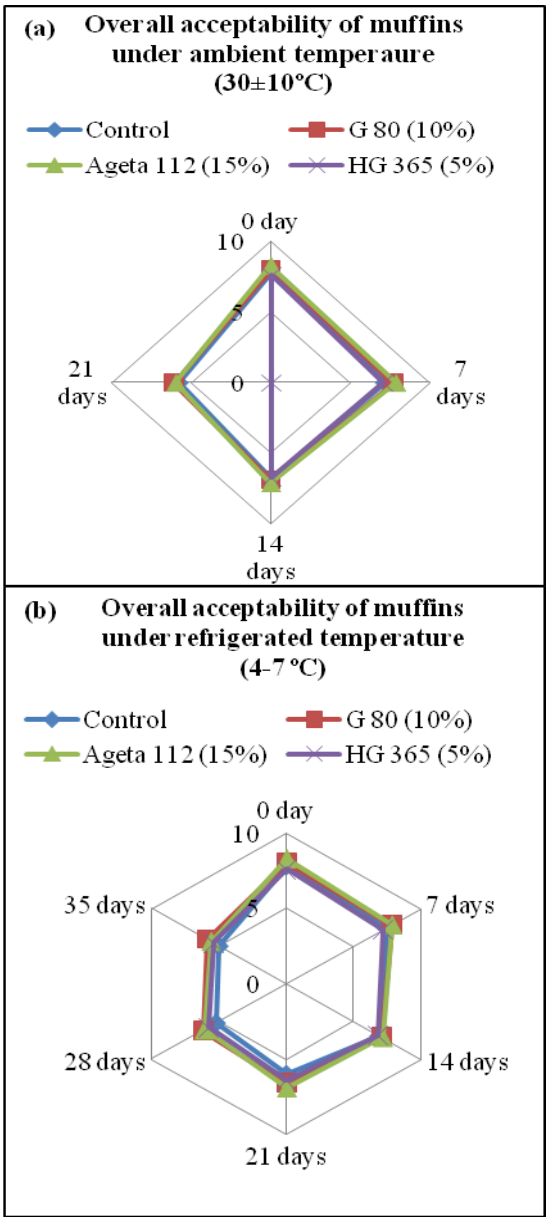


Fig. 12. Effect of storage conditions and period of storage on overall acceptability (maximum score 9.0) of muffins prepared by incorporation of selected best levels of autoclaved guar flour and packed in LLDPE

IV. CONCLUSION

The storage studies of guar flour supplemenattaion of muffins revealed good acceptability of the product. Guar bean, the legume, enhanced the nutritional value of muffins along with along with enhanced shelf life of the product. The higher water holding capacity reduced its water activity and thus contributed to longer shelf life of muffins. The free fatty acid value and peroxide values were lower with the guar flour supplemented muffins. Under refrigerated conditions the muffins were fir for consumption on 35th day of storage as well however also at ambient temperature the microbial analysis revealed lower microbial count in guar flour supplemented muffins. The overall acceptability as per the sensory evaluation concluded Ageta 112 supplemented muffins with better acceptability score among all other varieties.

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