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Development and shelf-life study of the deep fat fried bengal gram flakes

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Bengal gram is a major pulse crop in India, widely grown for centuries and accounts for nearly 40 per cent of the total pulse production. The present investigation deals with the development of Bengal gram flakes. The flakes was prepared by soaking the Bengal gram for 12 hours and then sun dried for 2 hours later on it was pressed and rolled with the help of heavy weight roller (10 kg). Physical study before and after flaking revealed that length, breadth and thickness were changed from 0.91 to 1.49cm, 0.70 to 0.25cm and 0.72 to 0.25cm, respectively. Samples were evaluated initially and after at the intervals 30, 60 and 90 days for sensory and physico-chemical analysis. Moisture content was increased from 1.20% to 2.92% from 0 day to 90 days of storage period. There was no change in ash content. Fat content was recorded as 24.39 to 24.38% from 0 days to 90 days. Protein was recorded as 21.86 to 21.81% and peroxide value was increased from 0.55 to 4.1 meq/kg from 0 to 90 days of storage period. Sensory results show that products of acceptable quality can be prepared. This study indicates the feasibility of developing such nutritious products.

Key Words : Flaking, Fried, LDPE, Physio-chemical changes, Shelf-life

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INTRODUCTION

India is a major pulse producing country which produces around 68% of worlds pulse production. Grain legumes constitute an important part of human and livestock diets in many parts of the world due to desirable nutritional properties. Besides being a rich and less expensive source of protein, they are also a good source of carbohydrates, minerals and vitamins (Chavan *et al.,* 1986; Tharanathan and Mahadevamma, 2003 and Zhang *et al.,* 2007). Chickpea (*Cicer arietinum* L.) is, an annual herbage and also known as Bengal gram or garbanzo bean, is a legume of economic importance and is the fifth important legume of the world on the basis of total production after soybean, peanut, beans and peas, which is mainly grown in the hot climates of India, Pakistan, Iran, Ethiopia, Mexico, and the Mediterranean area (Chavan *et al.,* 1986).

The shape, size, and colour of chickpea seeds vary according to the cultivars. Based on seed colour and geographical distribution, chickpeas are generally grouped into two types: *Kabuli* (Mediterranean and Middle Eastern origin) and *Desi* (Indian origin). The former type is with large, smooth coated, rams-head shaped and beige coloured seeds and the latter type is with small, angular, wrinkled and dark coloured seeds (Chavan *et al.,* 1986 and Saini and Knights, 1984). Chickpea contains on the average 22% protein, 4.5% fat, 63% carbohydrate, 8.0% crude fibre and 2.7% ash (Chavan *et al.,* 1986). Unlike many commodity crops, chickpeas are commonly edible

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after a primary process, such as utilised historically in whole or paste form as a main or side dish after cooking and in whole form as a snack food after roasting (Koksel *et al.,* 1998).

Convenience foods are a class of foods which impart convenience to the consumers by way of little or no requirements of major processing or cooking before their consumption. However, the complexity of Convenience foods lies in their composition, shape, size and method of processing. Viewing this heterogeneticity, transformation of the product into a simpler form with minimum handling prior to consumption speaks of the skill of the technologist. However, the major thrust is to provide convenience by way of saving the cooking time and labour. In addition, the additional convenience for long shelf-life, reduction in weight, good quality, easy commercial availability are of prime concern.

Hence the study is focused on development of bengal gram flakes. Apparently the first commercial production of such a food occurred around the turn of the century. Many complications have been introduced into the process since that time in attempts to improve the flavour and the efficiency of operation and to increase the uniformity of the flake. Hence, objective of this research was to evaluate shelf-life of flaked kernels at ambient temperature.

METHODOLOGY

Development of Bengal gram flake :

Bengal gram was procured from local market of Allahabad. *Cicer arietinum* L. was chosen for the present study. All impurities such as dust, chaff, stones, insect infested pulse, broken bengal gram and foreign materials were removed from bengal gram by hand picking. Grading was done for size separation of bengal gram at uniform size. Soaking was carried out for 12 h and then it was sun dried for 2 hours. Flakes were prepared by pressing and rolling soaked bengal gram with the help of heavy weight roller (10 kg). Flakes were fried on domestic gas for few minutes till desire colour appearance (golden brown colour). After frying, all the mixture (salt, red chilli powder, chat masala, dry mango powder) was added and mixed later on flaked mixture was packaged in LDPE bags and stored at room temperature.

Physical property:

The Bengal gram size, in terms of the three principal axial dimensions, that is length, breadth and thickness were measured using grain shape tester (K200, Japan) with an accuracy of 0.01 mm. The seed shape was also determined in terms of its geometric mean diameter, sphericity, roundness and aspect ratio. The geometric mean diameter (D_p) of the seed were calculated by using the following relationship and Bulk density is the ratio of the mass of a sample of seed to its total volume (Mohsenin, 1986).

Physico-chemical analysis :

Moisture content was determined by the method described in AACC (2000), Method no. 44- 15A. Ash content was determined by AACC (2000), Method no. 08-01. Fat content was determined by the method described in AACC (2000), Method no. 30- 25 Protein was determined by the kjeldhal method. It was determined by the AACC (2000) Method no. 32-10. Peroxides value was determined by titration method (AOAC, 1970). Sensory analysis was carried by 9-point hedonic scale AACC (2000).

OBSERVATIONS AND ASSESSMENT

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Physical properties :

Bengal gram expanded both longitudinally and axial during flaking. The results were in conformity with (Levine, 1993). Among these physical characteristics, mass, volume, projected area, and centre of gravity are the most important ones in the handling systems (Peleg, 1985). Other important parameters are width, length, and thickness (Mohsenin, 1986 and Peleg, 1985). Knowledge of length, width, volume, surface area and centre location of mass may be applied in the designing of sorting machinery, in predicting surface needed when applying chemicals, shape factor (sphericity) and yield in the peeling operation (surface area) (Wright, 1986). Before treatment, length, width and thickness of soaked Bengal gram was 0.91cm, 0.70cm and 0.72cm but after flaking length and width expanded 1.49cm and 0.25cm and thickness decreases after flaking 0.25cm. The high sphericity value suggests that the splits tended towards a spherical shape (Omobuwajo *et al.,* 2000) being near semispherical in shape. Sphericity was recorded 51.36 after flaking. There was slight increased in bulk density after flaking, it was found to be 2.4 g/cm^3. Mariotti *et al.* (2006) have reported a decrease in bulk densities due to puffing; the new organization of the outer layers and the high porosity of the matrix have been indicated to be responsible for the rapid hydration of the puffed materials and predominance of capillary water absorption is expected. An increase in the density of potato tuber also leads to a decrease in fat absorption. In one study of fried potato chips, tubers with a higher density (1.103 g/cm^3) yielded chips with lower fat content (42.1%) than slices with lower density of 1.093 g/cm^3 (48.8% fat) (Ufheil and Escher, 1996).

Quality analysis of Bengal gram flakes :

Moisture content:

Fig. 1 shows the changes in the moisture content during storage of Bengal gram flakes. The significant changes were observed in moisture content during storage periods. From this it is evident that moisture contents of all products increased during storage. In stored cereal products, moisture uptake depends on relative stored cereal products, moisture uptake depends on relative humidity (which was high) (Felt *et al.,* 1945). The moisture content of chips decreased from around 80% to almost 2% when they are fried (Table 1). However, the moisture removal inevitably leads to a considerable uptake of oil which amounts to around 35% of the mass of the chip (Aguilera and Gloria-Herna´ndez, 2000).

Ash content:

Fig. 2 and Table 2 show the changes in the ash content during storage of Bengal gram flakes. The non-significant changes were observed in Ash content during storage periods. Kaur (1990) also reported lower content of ash after frying than its raw counter parts. Loss of moisture and oil uptake takes place simultaneously through the mechanism of diffusion; however, it is still not clear how and when the oil is absorbed by the product (Moreira *et al.,* 1999).

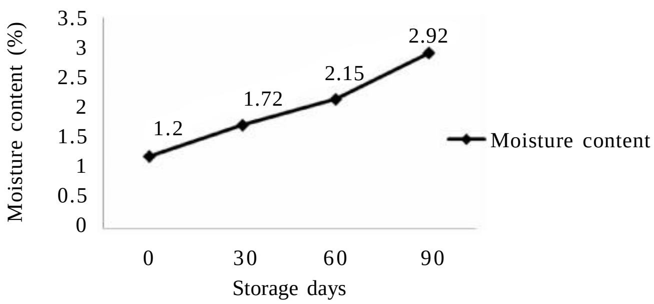

Fig. 1 : Effect of treatment on per cent moisture content during storage

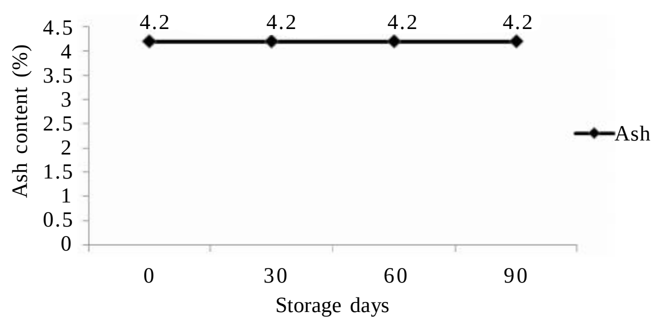

Fig. 2 : Effect of treatment on per cent ash content during storage

Table 1 : ANOVA of per cent moisture content

Treatments	Storage period (days)			
	0	30	60	90
Moisture content (%)	1.20	1.72	2.15	2.92
F- test	S	S	S	S
S.E. ±	0.1	0.1	0.1	0.1
C.D. (P=0.05)	0.292	0.292	0.292	0.292

S=Significant, S.E.± = Standard deviation, C.D.= Critical difference

Table 2 : ANOVA of per cent ash content

Treatments	Storage period (days)			
	0	30	60	90
Ash content (%)	4.2	4.2	4.2	4.2
F- test	NS	NS	NS	NS
S.E. ±	0.2	0.556	0.141	0.3
C.D. (P=0.05)	0.584	1.6235	0.4117	0.876

N.S.=Non-significant, S.E.±= Standard deviation, C.D.= Critical difference

Fat content :

Fig. 3 and Table 3 show the changes in the fat content during storage of Bengal gram flakes. The non-significant changes were observed in fat content during storage periods. The data clearly indicated that there was much increase in fat content this increase in fat content was due to addition fat used during frying. Deep fat frying is a process of simultaneous heat and mass transfer. Heat is transferred from the oil to the food, water is evaporated from the food, and oil is absorbed. Hira *et al.* (1995) found a decrease in fat content by 11.5 per cent during roasting and dehusking of chickpea seeds. Deep fat frying is also well known as the immersion frying. It is considered as a process of food dehydration and more exactly a procedure of water extraction by convection with change of state. In this process the food is submerged in the heating environment, usually oil, to a high temperature and in the presence of the air during different periods (Farkas *et al.*, 1996 and Larranaga *et al.*, 1999).

Protein content:

Fig. 4 and Table 4 show the changes in the protein content during storage of Bengal gram flakes. The data clearly indicated that there was slight difference in protein content Protein values found in the legumes were in agreement with data presented by other authors (Kutos *et al.*, 2003). Thermal treatment of legumes (as cooking) makes the consumption of these foods possible. The process considerably decreased naturally existing anti nutritional factors, increasing availability of others nutrients, such as protein (Domene and Oliveira, 1993). Salt is a versatile, multifunction ingredient in BGF, In the presence of salt, the quaternary structure of protein is stabilised and the lack of molecular expansion results in a less viscous protein system (Urbanski *et al.*, 1982). The salt soluble globulin proteins were 62.7% of total

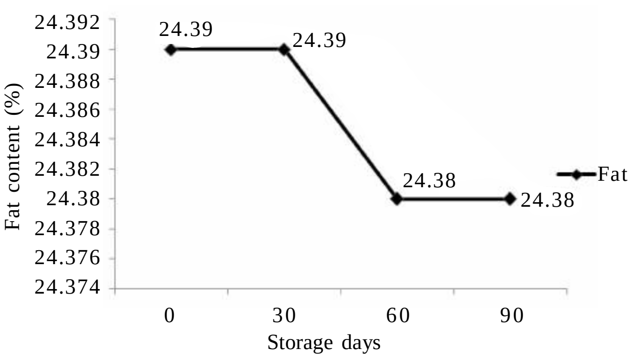

Fig. 3 : Effect of treatment on per cent fat content during storage

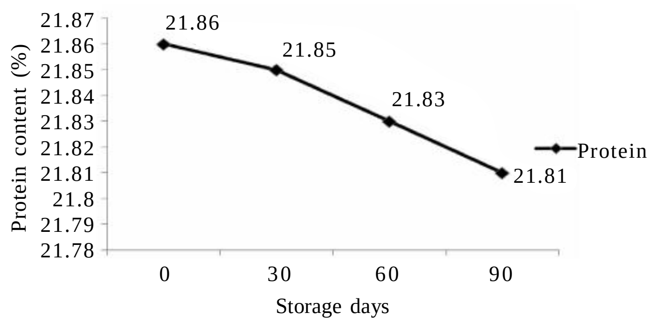

Fig. 4 : Effect of treatment on per cent protein content during storage

Table 3 : ANOVA of per cent fat content

Treatments	Storage period (days)			
	0	30	60	90
Fat content (%)	24.39	24.39	24.38	24.38
F-test	NS	NS	NS	NS
S.E. ±	0.2	0.447	0.346	0.5196
C.D. (P=0.05)	0.548	1.3058	1.0115	1.517

NS=Non-significant, S.E.±= Standard deviation, C.D.= Critical difference

Table 4 : ANOVA of per cent protein content

Treatments	Period (days)			
	0	30	60	90
Protein content (%)	21.86	21.85	21.83	21.81
F-test	S	S	S	S
S.E. ±	0.2	0.3605	0.458	0.2
C.D. (P=0.05)	0.548	1.0528	1.338	0.548

S=significant, SE ±= Standard deviation, CD= Critical difference protein (Chavan *et al.*, 1986).

Peroxide content :

Fig. 5 and Table 5 show the changes in the moisture content during storage of Bengal gram flakes. It has been shown that products can be consumed if the peroxide level is <5 meq/kg of oil. The peroxide value of the snack samples increased from 0.5 to 4.10 meq/kg for 90 days during storage. This could have been due to the rancidity in Bengal gram flakes, though they were packed in low density poly ethylene sealing procedure. But the peroxide values were within the acceptable limits and so can be consumed upto 2 months nicely. But after 2 months it is slightly increases. The samples will require antioxidant treatment after 60 to 90 days of storage to prevent the product from being rancid.

Peroxide values measure the content of

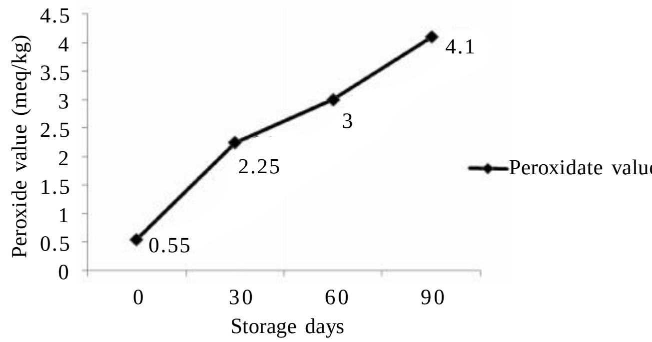

Fig. 5 : Effect of treatment on per cent peroxide value during storage

Table 5 : ANOVA of per cent value

Treatments	Storage period (days)			
	0	30	60	90
Peroxide value	0.55	2.25	3.00	4.10
F-test	S	S	S	S
S.E. ±	0.173	0.177	0.173	0.174
C.D. (P=0.05)	0.3534	0.3635	0.3534	0.3677

S=Significant, S.E.± = Standard deviation, C.D.= Critical difference

Table 6 : ANOVA of sensory evaluation

Treatments	Interval of storage days			
Sensory attributes	0	30	60	90
Colour	8.6	8.6	8.5	7
F test	S	S	S	S
S.E.±	0.1	0.141	0.141	0.141
C.D. (P=0.05)	0.292	0.4177	0.4117	0.4117
Taste	8.4	8.4	8.0	7.4
F test	S	S	S	S
S.E.±	0.1	0.141	0.1	0.141
C.D. (P=0.05)	0.292	0.4177	0.292	0.4117
Flavour	8.3	8.1	7.4	6.9
F test	S	S	S	S
S.E.±	0.1	0.173	0.19	-
C.D. (P=0.05)	0.292	0.5057	0.432	-
Texture	8.5	8.4	7.5	6
F test	S	S	S	S
S.E.±	0.1	0.1	0.1	0.1
C.D. (P=0.05)	0.292	0.292	0.292	0.292
Over all acceptability	8.4	8.3	8	7.5
F test	S	S	S	S
S.E.±	0.173	0.141	0.1	0.23
C.D. (P=0.05)	0.5057	0.4117	0.292	0.324

S=Significant, S.E.±= Standard deviation, C.D.= Critical difference hydroperoxides and are used as indicators of lipid oxidation (Gray, 1978). There was slight difference in peroxide content during storage. There was no much difference in rancidity during storage. The results were in conformity with (Kirk and Sawyer, 1991). In deep-fried snacks, off-flavour development due to rancidity causes unacceptability of the product. Crispiness of snack foods is desirable, but sogginess caused by moisture gain ultimately leads to poor texture and thus rejection of the product (Taoukis *et al.,* 1988). The most common tests recommended for assessing the quality of deep-fried snacks are moisture, acid-insoluble ash and fat contents, peroxide, and acid values of extracted fat (BIS, 1989). The changes in absorbance can be used as relative measures of oxidation (Che *et al.,* 1999). Chatzilazarou *et al.* (2006) showed a significant increase in olive oil PV after 10 h of frying, while in the corn oil, a significant change occurred after only 8 hours of frying, which are an agreement with the results is obtained in this study.

Sensory evaluation :

It is quite clearly depicted that there was no significant change observed in the appearance of treatment, slight difference was observed in the taste after "60 days" after which it becomes slightly rancid and flavour score indicated significant difference after 60 days. No significant difference in texture was observed. Change in colour was not observed. There was no prominent change throughout the storage period till 60 days. So, it is quite evident that BGF were made shelf stable during the storage period till 60 days (Table 6 and Fig. 6). This results in a brown surface forming on the food before the inside is completely cooked and immersing the food for a longer time to cook the inside properly may cause burning on the outside (Blumenthal and Stier, 1991). The medium in which frying takes place are usually oil. The use of oil with polyunsaturated fatty acids is desired from a health point of view. Even though it may influence key quality factors of the fried food like texture and appearance (Brinkmann, 2000), it is a widely accepted view that the balance of fatty acids does not significantly influence fat uptake (Bognar, 1998). Debnath *et al.* (2003) reported that the hardness of fried chickpea based snack increased at the lower moisture content of the pre-fried product. Significant increase in colour of the olive oil and corn oil after 8 and 6 h of frying potato, respectively was found (Chatzilazarou *et al.,* 2006). The traditional frying conditions produced chips with good quality attributes in terms of oil content, texture, and colour (Garayo and Moreira, 2002).

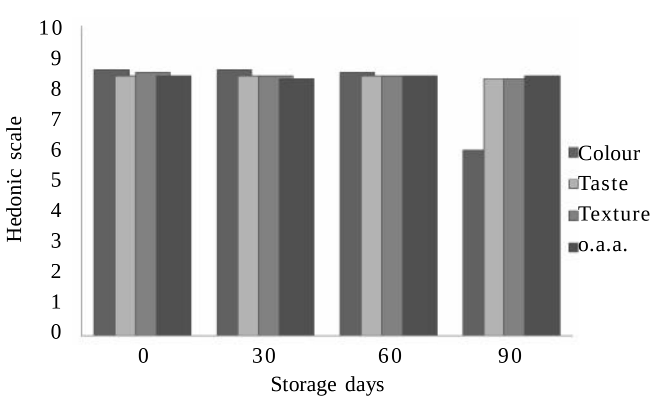

Fig. 6 : Effect of treatment on sensory evaluation during storage

Conclusion :

Physico-chemical and organoleptic evaluation showed that the developed bengal gram flakes was having good colour, flavour, aroma, taste, mouth feel and overall acceptability. Based on the data obtained from PV(meq/kg of oil) and sensory evaluation, the Bengal gram flake developed a rancid flavour/smell after 33 days of storage but it was found to be acceptable for the storage of 90 days. This study indicates the feasibility of developing such nutritious and convenience food products.

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