RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 12 | Issue 1 | April, 2019 | 31-35
ISSN–0974–2662 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/12.1/31-35**

Effect of composition and storage period on physico- chemical properties of jaggery based sweetmeat bar of maize

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Received : 23.02.2018; **Revised :** 06.02.2019; **Accepted :** 22.02.2019

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■ **ABSTRACT :** A study was undertaken to develop jaggery based sweetmeat bars of maize flour. For the optimization of products, three ratios of jaggery and flours of maize *viz.*, 4 : 6, 5 : 5 and 6 : 4 were selected in the study. Several physico-chemical properties (*viz.*, moisture content, pH, ash content, fat content and browning index), were evaluated for fresh samples *vis-à-vis* their counterparts packed in LDPE bags (100 gauge) and stored under ambient conditions for 30 and 60 days. Moisture content and browning index of products were higher for those having higher level of jaggery, whereas, pH, ash content and fat content were lower. Maize samples prepared with highest level of jaggery had moisture content, 11.25 per cent, pH, 5.39; ash content, 1.5 per cent fat content 1.853 per cent and browning index, 0.412. During storage moisture content and browning index increased, whereas, pH, fat content decreased, however, ash content remained constant.

■ **KEY WORDS :** Jaggery, Maize flour, Sweet meat bar, Physico-chemical parameters

■ **HOW TO CITE THIS PAPER :** Gupta, A.K. (2019). Effect of composition and storage period on physico- chemical properties of jaggery based sweetmeat bar of maize. *Internat. J. Agric. Engg.*, **12**(1) : 31-35, **DOI: 10.15740/HAS/IJAE/12.1/31-35.**

Jaggery and khandsari industry has been one of the ancient and important rural-based cottage industries in our country. Jaggery is a natural sweetener made by the concentration of sugarcane juice (FAO, 2007). In India jaggery is being produced by using the traditional methods. India is the largest producer and consumer of jaggery and jaggery based products. India produces more than 70 per cent of global production of the jaggery (Jagannadha *et al.*, 2007). In India 53 per cent of total sugarcane production is processed into the white sugar, while 36 per cent is processed for the production of jaggery in the rural area. Jaggery is prepared in all the states of India (Singh *et al.*, 2011). Prior to 1902 almost all the sugarcane produced was processed for manufacturing of Jaggery and khandsari. Later, while jaggery and khandsari industry remained practically static, the sugar industry made rapid stride. Number of sugar mills increased from one in 1902 to more than 600 in 2015. Even after such a phenomenal increase in number of sugar mills during the past 50-60 years, above 40 per cent of the total sugarcane produced is still being utilized for manufacturing of jaggery and khandsari. Although labelled as the poor man's sugar, most Indian consumes jaggery in some form or other. Jaggery contains large quantity of minerals in addition to energy and is consumed directly as sweetener (Singh and Singh, 2008). The micronutrients present in jaggery have anti biotic and anti carcinogenic properties. Its dietary intake can prevent different diseases (Jagannadha *et al.*, 2007).

Replacement of white sugar with jaggery does not alter the acceptability of the product. Variety of value added products of jaggery such as *Rasogolla*, *Peda*,

curd laddu (puffed cereal, nut and seasame etc) are popular in rural area (Gartaula and Bhattarai, 2014). Development of value added products of jaggery and packaging may safeguard the interests of the jaggery manufacturer.

METHODOLOGY

Jaggery (Chaku variety) and maize flour (free from pests) were procured fresh from the local market. The impurities were removed manually by visual inspection. Benzoic acid was used as preservative at the rate of 200 mg per kg of dry mixture of jaggery and maize for the preparation of sweetmeat bars. Finished sweetmeat bars were packed in 100 gauge LDPE bags for storage studies.

Product development:

Fresh maize flour was sieved through 20 BSS sieve. The maize flour was then roasted to remove uncooked flavour. Jaggery was crushed to small pieces and mixed with 200 ml of water per 1 kg of raw product followed by its heating to dissolve. Maize flour was mixed thoroughly with melted jaggery with continuous stirring and slow heating for 10 minutes. At last, heating was stopped followed by addition of benzoic acid with continuous through mixing. The mass thus, obtained was spread over the tray and allowed to cool down. Then it was cut into rectangular shaped pieces of size 4 cm x 2 cm x 1 cm. These pieces were then dried in a tray dryer for 4 h at 60°C to remove excess moisture. Sweetmeat bars were then packed in LDPE bags and stored for further studies.

Determination of physico-chemical properties:

Moisture content, ash content, browning index and crude fat (ether soluble material) were determined according to the method as recommended by Ranganna (2001). The electronic pH meter was used for pH determination.

RESULTS AND DISCUSSION

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

Effect on moisture content:

The final moisture content of fresh samples increased significantly as the percentage of jaggery increased in the samples. The average moisture contents of fresh samples with 40 per cent, 50 per cent and 60 per cent of jaggery were recorded as 10.75 per cent, 11.22 per cent and 11.25 per cent, respectively. Reasons for higher moisture content of samples having higher percentage of jaggery is the more hygroscopic nature of jaggery as compared to maize flour. Bhandari *et al*. (1997) and Bhandari and Howes (1999) have reported that monosaccharides and disaccharides have more hygroscopic nature in comparison to complex carbohydrates such as starch. During storage, moisture contents of all the samples irrespective of their composition were found to have significantly increased, progressively. For example, the average moisture content of fresh sample prepared with highest level of jaggery was 11.25 per cent, which increased to 11.87 per cent after 30 days of storage and subsequently to 12.66 per cent after 60 days (Fig. 1). The increase in moisture content may be attributed to water vapour permeability of packaging material (LDPE) and higher relative humidity of external environment. However, the moisture after 60 days of storage was higher in those prepared with intermediate level of jaggery as compared to those with lowest level.

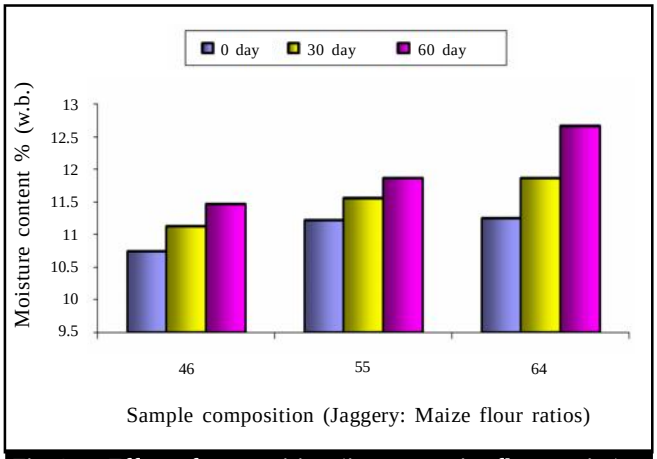

Fig. 1 : Effect of composition (jaggery-maize flour ratios) and storage period on moisture content of jaggery based sweetmeat bars of maize

Effect on pH:

pH of the samples were found to have decreased highly significantly with the increase in the level of jaggery (Fig. 2). Since jaggery had inherently low pH value, samples having higher percentage of jaggery evidently measure lower pH value than those having lower

percentage of jaggery. During storage, irrespective of product composition, the pH of all the samples decreased significantly (at P=0.05). For example, samples with lowest level of jaggery had initial pH value as 5.66, which decreased to average value of 5.54 after 30 days of storage and subsequently to 5.42 after 60 days. A decrease in pH value during storage may be attributed to production of acidic compounds due to probable activities of micro-organisms might be present in the sample and also to the oxidation of fat that would have occurred during storage. During storage increase in moisture content and availability of oxygen would have provided favourable conditions to micro-organisms to grow and subsequently hydrolyse carbohydrates into acids resulting to lowering of pH.

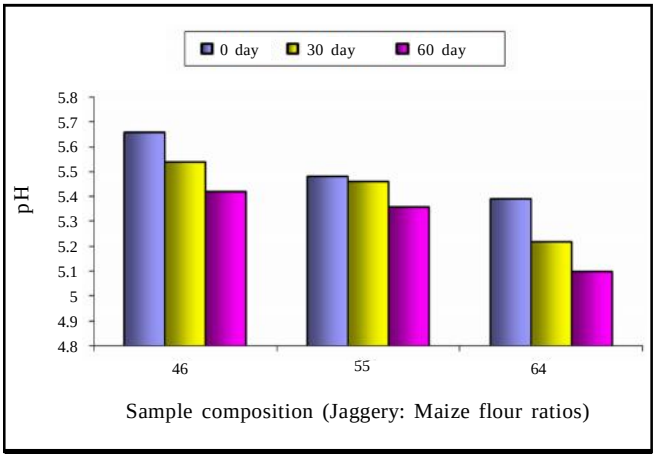

Fig. 2 : Effect of composition (jaggery-maize flour ratios) and storage period on pH of jaggery based sweetmeat bars of maize

Effect on ash content:

Total ash content of the samples decreased as the ratio of jaggery increased. The average ash content of fresh samples with 40 per cent, 50 pe cent and 60 per cent of jaggery were found to be 1.89, 1.58 and 1.50, respectively (Fig. 3). This decrease in ash content is evidently because of lower ash content of jaggery as compared to maize flour. Ash content of jaggery was 0.47 whereas the reported value of maize is 2 per cent (Ceniceros and Singh, 2001). The effect of composition on the total ash content of samples were found highly significant (at P=0.01). During the storage no change in ash content were recorded after 30 days whereas a slight increase in the values were found after 60 days of storage. For example, the ash content of sample with highest level of jaggery remained unchanged for 30 days of storage at the value of 1.50 per cent. This however, change to 1.51 per cent after 60 days. It has been reported by Bano *et al*. (1979) that total ash content is not affected by any treatment, packaging materials, storage conditions, even by ashing at high temperature.

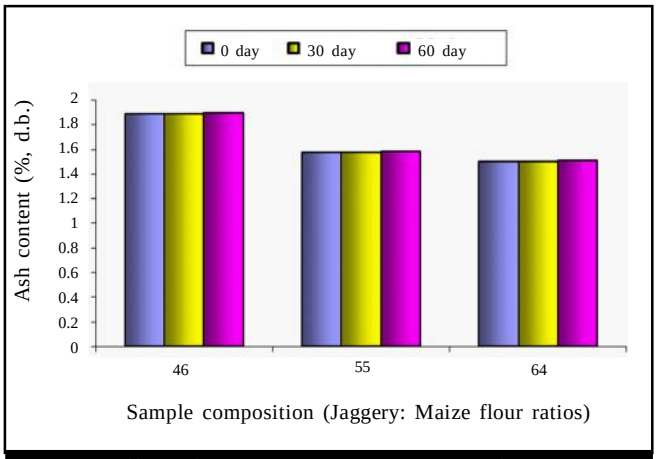

Fig. 3 : Effect of composition (jaggery-maize flour ratios) and storage period on ash content of jaggery based sweetmeat bars of maize

Effect on fat content:

Results of the study indicate that increase in jaggery level caused a significant decrease in the fat content of the samples. This trend of fat content of samples was because of the fact that maize inherently has higher fat content as compared to jaggery (Fig. 4). The fat content of jaggery selected in the study was found to be 1.63 per cent, whereas, that of maize flour was 4.5 per cent. It is obvious that the product which has lower ratio of jaggery *i.e*. higher ratio of maize flour, will have higher fat content and *vice versa*. The results of the study revealed that highly significant decrease in the fat content took place during storage in all the samples. The fat content of fresh samples having highest level of jaggery was 1.853 per cent, which decreased to 1.212 per cent and further 0.852 per cent after 30 and 60 days of storage, respectively. The loss of fat content was found to be maximum in case of sample with lowest level of jaggery and minimum in that with highest level of jaggery. The decrease in fat content during storage may be because of decrease in ether extractable fats as a result of conversion of part of the fat, due to rancidity, into such compounds which are insoluble in ether. Another

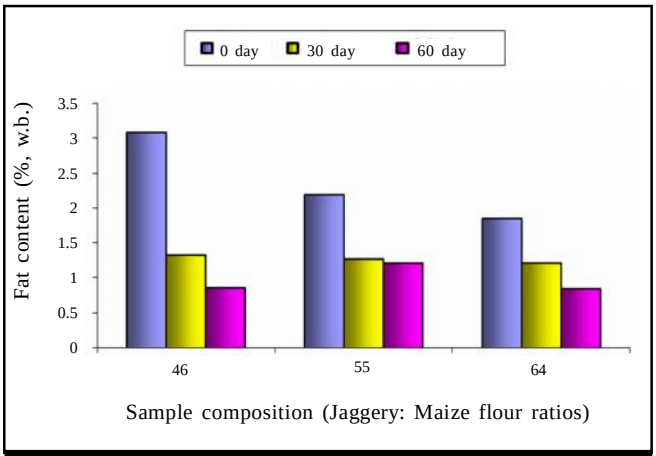

Fig. 4 : Effect of composition (jaggery-maize flour ratios) and storage period on the fat content of the jaggery based sweetmeat bars

reason was the gain of moisture during storage, which caused an apparent decrease in fat content as they are reported on the whole weight basis.

Effect on browning index:

A marginal increase in the browning index was observed with the increase in level of jaggery in the samples. However, the increment was non-significant. Since the jaggery, due to caramalization of sugar during processing is browner in colour as compared to roasted maize flour, this trend was observed.

Browning index was found to have increased progressively during storage (Fig. 5). Statistical analysis shows that the change in the browning index was highly significant. For example, fresh sample with lowest level of jaggery had average browning index as 0.366, which increased to 0.489 and further to 0.561 after 30 and 60 days of storage. Increase in the browning index may be attributed to non-enzymatic Maillard browning which occurs due to condensation reaction among carbohydrates, amino acids and other organic acids. During storage an increase in acidity and presence of carbohydrate and protein would have accelerated the browning reaction leading to increase in browning index.

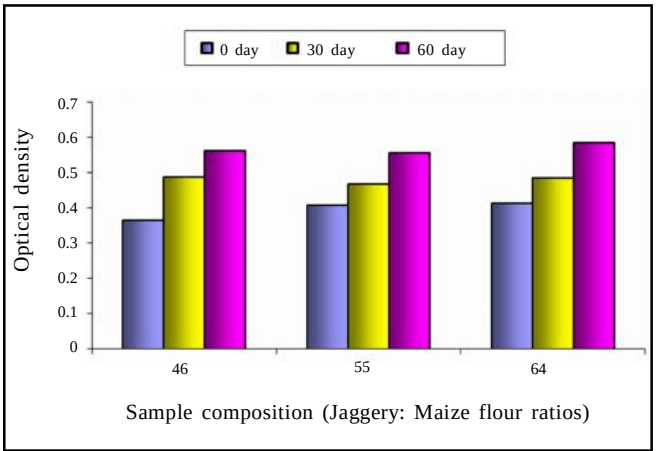

Fig. 5 : Effect of composition (jaggery-maize flour ratios) and storage period on browning index of the jaggery based sweetmeat bars of maize

Summery and conclusion:

Chaku variety of the jaggery selected in study had moisture content, 10% (w.b.); fat content, 1.63 per cent, total ash, 0.47 per cent, optical density, 0.39; pH, 5.14; acidity; 0.15, and bulk density, 1.46 g/cm$^{3.}$ An increase in moisture content in fresh samples of the product was observed with the increase in the level of jaggery. During storage moisture contents of samples of the products increased progressively. pH of the samples of the product were found to have decreased significantly with the increase in level of jaggery. During storage, all the samples recorded lower pH values as compared to their fresh counterparts. Ash contents were found higher in those samples which had higher percentage of flour. During storage, ash content remained almost constant. Fat content of the samples of both the products were found higher in those having higher level of flours. During storage, decrease in fat content was observed in all the samples. Samples having higher amount of jaggery recorded higher browning index which increased significantly during storage.

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