Determination of changes occurrence in physical, chemical and organoleptic properties of papadam during storage

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Abstract

Papadam is a delicious food product and highly susceptible for quality deterioration during shelf life. In order to asses quality degradation, four kilo gram of finely ground black gram flour (300 micron) was taken and mixed with 1kg of wheat flour and added 2 liters of salt-bicarbonate solution while mixing. The mixing process was carried out for 10 minutes until formation of a dough with a suitable consistency. Prepared dough was passed through rollers to form a sheet with about 4cm thickness. The thin dough sheet was passed through nylon rollers to get a very thin dough sheet (1mm) which was cut into papadam disks using a disk cutter.

Prepared wet papadam were subjected to two-factor factorial experimental design using two variables namely moisture content and drying method at two levels in order to determine factors responsible for quality changes of papadam during shelf life. Therein, the prepared wet papadams were divided into 4 portions and two portions were dried in the sun in order to get two moisture contents 15.5 - 16.5% and 13.5- 14.5% respectively. The rest two portions were dried in a hot air dryer to get the same two moisture contents. Prepared papadam were packed in double laminate pouches and stored under normal environmental condition for 4 months. Samples were drawn from each treatment monthly including just after preparation too to determine changes occurrence on pH, puffing quality and organoleptic properties. All treatments were replicated thrice and data obtained from the study were analyzed using parametric as well as non-parametric (Kruskall-Wallies) ANOVA.

Key words: Papadam, Black gram, puffing quality, salt-bicarbonate solution, dough sheet, primary and secondary rolling, papadam khar, organoleptic properties, pH declining

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Introduction

Papadam is a demanding food product for the Asian cuisine particularly for the dish with rice and curry; because papadam has the capacity to beautify the dish to attract the eater towards the food. Moreover, this product is playing a vital role at social eating too, at where it acts as a food decorator as well as food stimulant for the rest of food. And also consumers inadvertently and emotionally perceived the other foods in the dish are delicious with the presence of papadam. Therefore, no food product in the dish other than the ppadam is capable to fill the void left out by the papadam at a social event. Even though, papadam is a delicious food product, its deliciousness is largely remained at fresh and declines it rapidly with the shelf life. Hence substantial amount of this product is coming back to the manufacturer as market return with the aging process and this transaction between the trader and the producer is a huge quality cost for the industry and it contravene the concept of cleaner production too. Therefore, aim of this research study is to determine what factor/s is affecting for the declining of quality of papadam specially puffing quality, pH value and organoleptic properties as against shelf life.

Material and method

Materials:

Papadam prepared out of Black gram flour, Wheat flour, common salt and sodium bicarbonate and prepared papadam were packed in double laminate flexible pouches

Methodology

Preparation of Salt-bicarbonate solution

One kilo gram of common salt was dissolved in 8 liters of water and brings it to boil in a stainless steel vessel. While boiling, 850g of sodium bicarbonate was added into the boiling salt solution and mixed well and put out the heat source thereafter. The hot solution was allowed to cool and kept for 6 hrs in order to precipitate impurities and other types of suspended solids. The clear salt-bicarbonate solution which contains both sodium carbonate as well as sodium bicarbonate (Approximately 60-65% sodium carbonate and 30-35% sodium bicarbonate) was taken from the top of the vessel (Papadam khar) and it was used in preparing of papadam.

Preparation of Papadam dough

Four kilo gram of finely ground black gram flour (300 micron) was taken and mixed with 1kg of wheat flour while adding 2 liters of salt-bicarbonate solution little by little. The mixing process was continued for 10 minutes until formation of a dough with a suitable consistency. Prepared dough was passed through primary and secondary rollers of rolling machine to form a dough sheet with about 4 cm thicknesses. The thin dough sheet was passed through a nylon roller machine again to get a very thin dough sheet with 1mm thickness. Finally dough sheet was cut into papadam disks (10cm diameter)) using a disk cutter.

Preparation of Papadam samples

Prepared wet papadams were subjected to two-factor factorial experimental design using two variables namely moisture content and drying method at two levels in order to determine what factor/s are responsible for quality changes of papadam during shelf life. Therefore, prepared wet papadam were divided into 4 portions and two portions were dried in the sun in order to get two moisture contents 15.5 - 16.5% and 13.5-14.5% respectively. The rest two portions were

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dried in a hot air dryer (Mechanical drying) to get the same two moisture contents. Prepared papadam out of 4 treatments were packed in double laminate pouches and stored under normal environmental condition ((26-28^{0}C & 68- 72%RH) for a period of 4 months. Samples were drawn from each treatment monthly including just after preparation too to determine changes occurrence on pH value, puffing quality and organoleptic properties. All treatments were replicated thrice and data obtained from the study were analyzed statistically using parametric and non-parametric (Kruskall-Wallies) ANOVA.

Determination of pH value of Papadam

pH value of Papadam was determined according to the methodology described by Sri Lanka Standards institution SLS 280/2009. Therein, 5g of papadam was taken and soaked in 50ml of distilled water for half an hour and thereafter the content stirred well to get uniform aqueous suspension. The electrode of the pH meter was inserted to the suspension and recorded the pH value.

Determination of puffing quality of papadam

A Puffed papadam was taken and placed over a graph paper and outer periphery of it was demarcated. Thereafter, puffed areas were broken and removed carefully using a hook. The empty areas left out by the papadam disk were carefully marked over the graph paper again. Finally area of the papadam as well as puffed areas were calculated with respect to the small squares of the graph paper.

Determination of organoleptic properties of papadam

Fried papadam taken from four treatments were subjected to sensory evaluation with respect to four sensory stimuli namely taste, color, crispiness and aroma using a 5 point unipolar hedonic scale. The sensory evaluation was carried out by employing 10 member trained sensory panel and asked them to indicate their choice by a numerical number. Data obtained from the evaluation were analyzed with respect to Kruskall-Wallies non parametric ANOVA.

Results and Discussion

The data obtained from the study pertaining to the physical, chemical and organoleptic properties of papadam, prepared from four treatment combinations were analyzed with respect to one month, two months, three months, four months and just after preparation.

Changes occurrence on puffin quality of papadam

Since puffing quality of papadam is a physical characteristic, changes occurrence on which were monitored monthly for a period of four months and results are given in the figure 1.

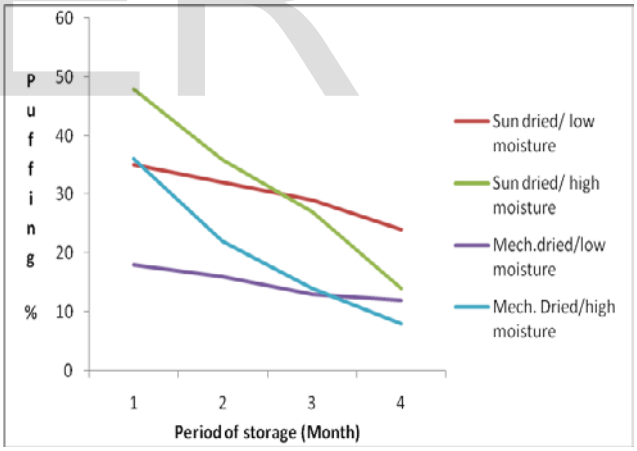

Fig. 1 Puffing quality of papadam during storage

The graph in Fig.1 Clearly indicates that percentage of puffing of papadams declines continously throughout of their storage period, however that take place in different magnitudes. If papadam stored at high moisture content this phenomenon is more significant than the papadam stored at low moisture content. It is

evident that papadam dried in the sun to get low moisture content (13.5 – 14.5%) havig a high degree of puffing than the papadam dried in a hot air dryer to get the same moisture content. Generally puffing quality of papadam is depending on four factores namely moisture content, amount of leavening agent – Sodium bicarbonate which directly relates to the pH value of the product too, quality of Black gram flour and amount of salt presence in the product itself. However, fresh papadam at high moisture content initially causes to high degree of puffing but subsequently the moisture content itself is badly affecting to decline the puffing quality. The mechanisam of papadam puffing is three fold, when papadam is inserted into hot oil, the moisture in the papadam itself is promptly converet into steam and liberate at high pressure along with the CO_2 gas from the leavening agent – $NaHCO_3$. The protein content in Black gram flour, the major constituent in papadam perticularly globulin fraction is capable to arrest these high presure steam and CO2 gas upto some extent by expanding it's surface area which is called puffing. Reddy et al., 1989 reported that protein content of black gram ranges from 23.6 to 28.9% and protein consists of **24% albumin**, 46.2% globulin and 0.9% prolamine. Moreover, the salt content (Preferably up to 3.0-5.0%) in papadam further facilitates for this mechanisam. Sathe et al., 1983 also reported same conclusion on role of sodium chloride in puffing of papadam. Prabhkhar and Jayaraj, 1973 also reported that fresh papadam usually having a high percentage puffing than the aged papadam and sodium bicarbonate & moisture impart expansion of papadam during frying

When papadam is stored at high moisture content along with Sordium bicarbonate usually around 3.0-3.5%, the fat in the product initially hydrolized and formed fatty acids and these fatty acids are liable for down grading of the strength of the leavening agent. Moreover, polypeptide chains of protein in papadam are also subjected to peptization as well as de-amination processes under alkaline condition along with the high moisture content. While formed amno acids cause to further down grading of the strength of the levening agent, the amine portion ($-NH_2$) is also detached from the amino acids. Eventually, detached $-NH_2$ portions convert into ammonia gas under alkaline condition.

Moreover, when papadam is stored at high moisture content, the free water available in the papadam causes to further degradation of liberated fatty acids and as a result of that an unplesant smell is emmiting from the finish product. Mechanically dried papadams are also showing somewhat low puffing quality than the papadam dried in the sun. Reason for this consequence is, drying of papadam in the dryer was taking place at a higher temperature around 60-65^{0}C than the papadam drying in the sun drying yard, where maximum temperatutre was around 40-45^{0}C. Thus, Sodium bicarbonate in the papadam, being tend to decompose into Sodium carbonate, water and carbon dioxide in the oven itself at high temperature. Formed sodium carbonate react with OH^- ions, which are formed by ionizing of water molecules in the oven at high temperature and formed NaOH. Formed NaOH reacts with the protein in the papadam. Hence, continous utilization of $NaHCO_3$ to formed NaOH, Carbon dioxide liberation capacity of the leavening agent is gradually coming down, consequently puffing ability as well as pH value of the product are also getting down.

To further scrtinize the out come of the study, data pertaining to the puffing quality were analized statitically using parametric ANOVA. Result revealed that calculated F value (26.5) is higher than the table F_{12}^3 value (3.41). Therefore, there is a significant difference between the treatments. Further calculations

with respect to least significant ratio(LSR) revealed that best treatments in maintaining of puffing quality of papadam was sundried papadam at low moisture content as mean value of it (16.0) was higher than the LSR value (6.49).

Chemical properties of papadam

pH value

As pH value of papadam is a chemical characteristic, changes occurrence on which were monitored monthly for a period of four months and outcome is given in the table 1.

Table 1 Changing of pH value of papadam during four months period of storage

Treatment combination	Average pH value of papadam					Mean ± SD
	Period of storage (Month)					
	0	1	2	3	4	
Sun dried / low moisture	9.7	9.5	9.4	9.2	9.0	9.3±0.30
Sun dried /high moisture	9.9	9.6	9.2	8.5	8.0	9.0±0.90
Mechanically dried / low moisture	9.0	8.9	8.7	8.6	8.5	8.7±0.25
Mechanically dried / high moisture	9.3	9.0	8.5	8.0	7.4	8.4±0.92

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The data given in the table 1 indicates that declining of pH value of papadam in all treatments take place gradually throughout of their storage period, however at different rates. According to the results, the rate of pH decline at high moisture content is greater than that of low moisture content. Reason for this consequence is hydrolization of fat and peptization of the protein in the product as described in declining of puffing quality at high moisture content. Hence, formed fatty acids (That react with Na_2CO_3 in papadam and convert into their salt) as well as by-product of the peptization process cause to scale down the pH value of the product. However, papadam at low moisture content around 13.5-14.5%, this process is taking place at a lower phase than that of at higher moisture content. Hence, declining of pH value of papadam at low moisture content is lower than that of at high moisture content. Chaudhary et al., 1985 also reported that initial pH value of fresh papadam is merely depending on the quality of salt-bicarbonate solution or papadam khar and later it may cause to decline due to various physic-chemical factores.

Determination of organoleptic properties of papadam

Organoleptic properties of papadam pertaining to the four treatment combinations were determined by conducting a sensory evaluation for just after and four months after preparation of papadam with respect to four sensory stimuli namely taste, color, crispiness and aroma. However, results revealed that there was no significant different between four sensory stimuli of fresh papadam (Just after making) of each treatment; because respondents in the sensory panel were unable to discriminate these

properties against each other. But in contrast, there was a significant different between the sensory stimuli of these treatments after four months of shelf life. Thus, the response of the respondents were analyzed with respect to Kruskall- Wallis non parametric ANOVA and results revealed that H values for taste, color, crispiness and aroma 31.2, 30.03, 28.17 and 35.45 respectively were higher than the chi square table value $X^2_{0.95}$ 7.815. Therefore there is a significant difference between the sensory stimuli of each treatment.

To further investigate the outcome of the analysis, mean separation was performed and results are given in the table 2.

Table 2 Mean rank value of four treatments for the four sensory stimuli in ascending order

Treatment	Mean rank value of papadam for four sensory stimuli after 4 months of storage in ascending order				Z Table value
	Taste	Color	Crispiness	Aroma	
Mechanically dried high moisture papadam	6.6	6.58	7.0	8.3	
Sun dried high moisture papadam	14.0	14.1	14.0	15.3	8.26
Mechanically dried low moisture papadam	29.0	31.5	30.0	30.6	
Sundried dried high moisture papadam	32.0	29.5	31.0	30.5	

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The statistically analyzed data in the table 2 indicate that there is no significant different between sun dried and mechanically dried papadam at low moisture content for the sensory stimuli taste, color, crispiness & aroma even after 4 months of shelf life. And also these two treatments were able to secure highest mean rank values for all sensory stimuli as against the papadam (either they dried in the sun or in a mechanical dryer) of rest two treatments at high moisture content. Reasons for the poor rating of high moisture papadam were:

Pungent taste due to rancidity of fat and lack of peculiar papadam taste due to degradation of protein in black gram flour particularly globulin fraction,

Occurring of poor color due to Millard browning reaction (which takes place in papadam at high moisture content during storage),

Degradation of crispiness of high moist papadam during storage this is also caused by declining of pH and protein content because these two constituents are critically important for maintaining crispiness as well as puffing quality of the fried product and

Poor aroma of wet papadam, this is also caused by rancidity of fat and liberation of ammonia from protein; however stench of rancidity is stronger than the stink of the ammonia gas.

To justify the influence of the variables on sensory stimuli of each treatment further, sensory profiles were drawn by taking into

account of mean response of the respondents and the outcome is depicting in figure 2.

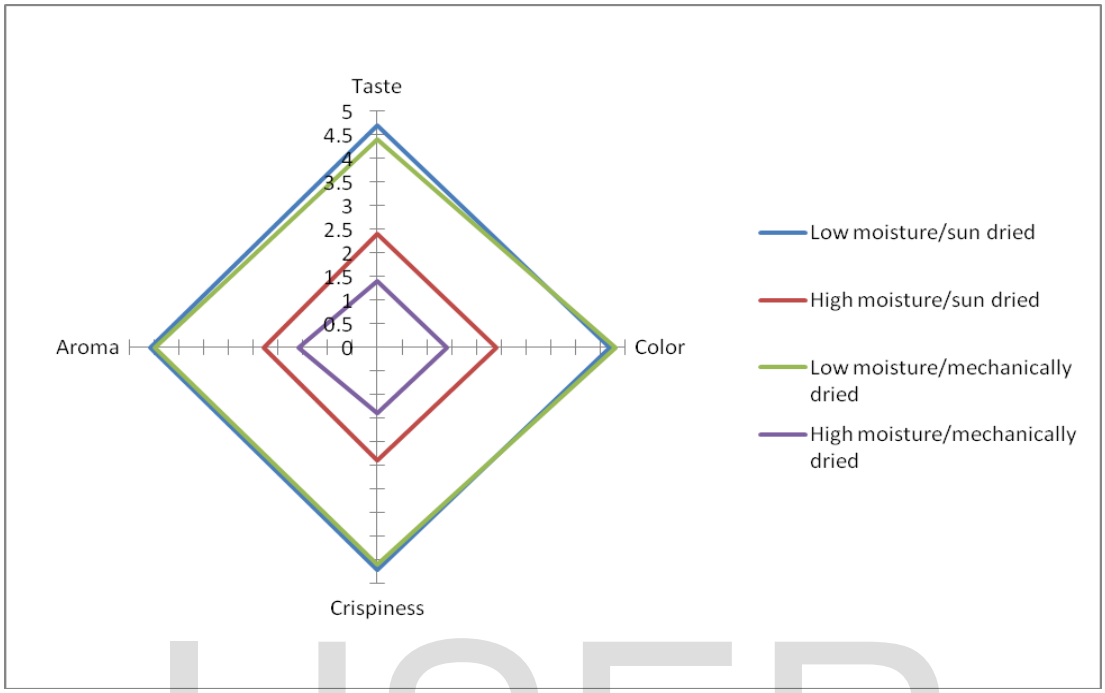

Fig. 2 Sensory profiles of the four treatment combinations of fried papadam

The sensory profiles given in the fig. 2 also indicate that best two treatments were low moisture papadam dried either in sun or in a dryer. However, according to the study very best treatment was papadam dried in the sun to get low moisture content at 13.5 – 14.5%. Reason for this phenomenon is the drying temperature. When wet papadam is drying in the sun which takes place in a lower temperatures around 40-45^{0}C, at where degradation of sodium bicarbonate is minimal than the mechanical drying, which take place relatively at high temperatures usually around 65- 70^{0}C.

Conclusion

Results revealed that best initial moisture content and pH value in maintaining of puffing quality and organoleptic properties of papadam during shelf life were 13.5 – 14.5% and 8.5 – 9.0 respectively. If moisture content exceeds more than 15.5%, quality of papadam degraded drastically during storage. Moreover, in order to maintain right pH value of the papadam, the salt-bicarbonate solution must be prepared appropriately by incorporating correct amount of common salt (1kg), sodium bicarbonate (850g) and water (18 liters). The wet papadam, just after making must be dried as quickly as possible. If it delays unnecessarily, pH value of wet papadam declines rapidly and consequence of it, is lowering the keeping quality of the finish product. Further, wet papadam must be dried under low temperature condition preferably less than 55^{0}C and fresh black gram flour must be used because it contains more globulins. Nevertheless, sun drying is more appropriate in drying of wet papadam than the mechanical drying.

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