International Journal of Food Science and Nutrition
ISSN: 2455-4898
Impact Factor: RJIF 5.14
www.foodsciencejournal.com
Volume 2; Issue 6; November 2017; Page No. 45-48

Effect of silica gel desiccant on the sensory quality of rice crackers

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Abstract
Sensory profile of a food plays an important role on the subconscious expectations we have while we eat. This study represents an overview of the sensory quality of rice crackers that is affected by the amount of silica gel desiccant used in packaging. Desiccants such as silica gel are used inside the package of hygroscopic food products to reduce the moisture absorption by the product itself. Four treatments were made by inserting 5g, 2.5g, 1g of silica gel in breathable sachets to each 100g rice cracker packet along with a control sample. These were stored under ambient conditions. Rice cracker packing material combination was 20µ BOPP+12µ MET PET+25µ CO EXCPP with 60µ thickness. Moisture content measurement and sensory evaluation were performed in every two month intervals up to 6 months' storage. 21 semi-trained panelists were used as the sensory panel. Ranking method with a 5-point hedonic scale was used to measure the variation of sensory stimuli pertained to appearance, odor, taste, crispiness and overall acceptability of rice crackers. Ranking data were recorded and analyzed using one-way ANOVA in MINITAB 17 statistical software. At 0.05 significance level, rice cracker 100g packed with 5g silica gel was confirmed as the highest consumer preferred sample with the least deterioration in its sensory properties.

Keywords: crispiness, desiccant, rice crackers, sensory evaluation, silica gel

1. Introduction
Generally, wheat flour is a major ingredient in almost all snacks. Many people are suffering from gluten intolerance so the development of gluten-free snacks that exploit the anti-allergenic and health-enhancing properties is interesting [1]. Due to the large consumption of snack foods, production of nutritious snack food is beneficial to the well-being of society. Rice flour is rich in vitamin B1, vitamin B2 and vitamin B3. It has highly digestible starch and good- quality protein among the cereals. Its oil is rich in linoleic acid and unsaponifiable matter (lipid antioxidants). Rice is hypoallergenic (gluten-free). Therefore, as a new trend numerous value added food such as crackers, noodles etc are produced using rice flour. Crackers are a versatile food consumed by many people. Its low cost of production, ease of flavoring, varied flavors, and long shelf life make it to meet the consumer demand. It is a nutritious and convenient snack.
Since these products do not need cold temperatures for preservation, they are popular for camping trips, hunting and fishing expeditions and other activities where refrigeration may not be available. In addition, they are convenient products to have in your cupboard [2]. Good quality cracker requires an expansion of low oil absorption, puffing, crispiness, flavor, low moisture absorbance. From these attributes crispiness is the crucial factor related with the acceptance of food such as crackers. Crispness and consumers' preference were reported to be ranked in the same order and it is important in food acceptability [3]. The overall sensory appeal of the cracker is associated with its appearance, taste, crispiness and odor.
Rice flour is a hygroscopic product which means rice crackers too inherit that property. Therefore, moisture absorption by crackers can lead to lose its favorable organoleptic properties as well as lose of texture, development of free fatty acids, microbial reactions and development of unpleasant volatile chemicals. Furthermore, to reduce the deterioration of its quality, several mechanisms are used in the packaging technology. Using a packing material combination with good barrier properties, using desiccants, modified atmospheric packing are few of the mechanisms practiced in the industry for hygroscopic foods.
According to Brody *et al*., 2001 [4] desiccants started the active packaging era with their addition into dry product packages to adsorb moisture. Desiccants can be contained in a moisture permeable sachet, pouch, patch, coupon, label, etc. The desiccant sachet is incorporated into the package to absorb water vapor from the contained product and from the package headspace, as well as any water vapor that enters by permeation or transmission through the package structure [4]. Desiccants are widely used in food and non-food products to reduce the moisture absorption by the products itself. Silica gel is used as a desiccant in food and nonfood products. There are two types of silica gel as indicating silica gel and non-indicating silica gel. Basically indicating silica gel has the Cobalt Chloride as the color indicator which is a salt of the heavy metal Cobalt. Therefore, indicating type silica gel is not used in food products as it includes heavy metal cobalt. Non indicating type silica gel is widely used in food industry as a desiccant. Non indicating silica gel is cheap and effective. And it is available in bulk form and sachets. There is no chemical reaction taken place in silica gel in adsorbing moisture. It is only the adherence of water vapor into the

micro cavities of silica gel which happens due to the difference of water vapor gradient between the surrounding environment and the micro cavities in silica gel. Normally the water vapor pressure inside the cavities in silica gel is lower than the surrounding environment. Therefore, the moisture adsorption is taken place till the cavities are saturated or till the water vapor pressure of the surround environment and micro cavities have gained an equilibrium. Even after reaching its maximum adsorption silica gel remains unchanged in shape and still appears as a dry product [5]. Sensory evaluation has been defined as a scientific discipline used to evoke, measure, analyze and interpret those responses to products as perceived through the senses of sight, smell, touch, taste and hearing [6]. The visual sense of rice crackers is often combined with color but in depth it can be linked with several sensory attributes such as texture, expansion, puffiness etc. Specific taste is given to the rice crackers through gene variation in rice variety, flavor powder substances, oven temperature and ingredients used in dough kneading. Meanwhile the taste is also affected with the hygienic conditions in processing. Off flavors are developed by microbial activity and chemical reactions such as hydrolytic rancidity. With respect to the moisture content, taste can be greatly affected by hydrolytic rancidity. It produces peroxides and free fatty acids which gives off flavors. Further oxidation of free fatty acids can produce aldehydes, ketones and alcohols which also give off flavors and odors. So the effectiveness of silica gel in protecting the product original taste is assessed in the sensory test.

Odor is also used as one of the most important parameters in a sensory test. If the silica gel is not effective in adsorbing the moisture, the oil will develop hydrolytic rancidity and make off odors. The type of odor can be descriptively termed by a well-trained sensory panel. Examples of descriptive terms for oxidation end products produced by an oil or a fat include rancid, painty, beany, green, metallic, and stale [7]. Crispiness and crunchiness have traditionally been associated with the mechanical force required to compress food until it fractures into small pieces, but these relate to the ease of fracture or fracturability, brittleness of a structure. Also, there are audible aspects to crispness and crunchiness that suggest that they are due to a combination of acoustic output and rigidity of the structure or its mechanical strength [8]. The overall acceptability of the product is a sensory parameter which indicates the final quality assessed by the panelist. It can be assessed as a whole sensory picture of the food. The primary consideration for selecting and eating a food commodity is the product's palatability or eating quality. Other quality parameters such as nutrition and wholesomeness are secondary [9, 10]. The objective of the study was to find out the effect of silica gel desiccant on the sensory quality of rice crackers throughout 6 months of ambient storage.

2. Materials and methods

2.1 Moisture content

Each rice cracker sample was opened and using the mortar and pestle, 5g of rice crackers were grounded until a fine powder was obtained. Then 5g of the fine powder was put onto the clean tray of moisture analyzer. At 108^0C within 6 minutes' moisture content is recorded for w/w% basis. Moisture content was recorded for all four samples on every 2 month intervals up to 6 months.

2.2 Sensory Evaluation

On the day of evaluation, panelists were served four rice cracker samples in a randomized order. The samples were prepared according to good hygienic practices. The samples were labeled with 3 digit random numbers to avoid the biasness. Panelists were given bottled spring water to rinse their mouth before and between each tasting. The sensory evaluation was done at the end of every two-month storage up to 6 months. Panelists rated the samples according to the intensity of each sensory attribute. The evaluated attributes were appearance, odor, taste, crispiness and overall acceptability. Sensory evaluation was done using a quantitative descriptive analysis on a five-point hedonic scale using 21 semi trained panelists in a general sensory laboratory. Hedonic scale "1" represented "dislike very much" while "5" represented "like very much". The panelists were informed about the purpose of the study and the participation was voluntary and the responses were kept confidential. Mean values were recorded and analyzed using one-way ANOVA. The hypothesis was written as follows;

H_0 /null hypothesis = All the samples have the same mean.

H_1/alternative hypothesis = At least one mean is different from the others.

Significant difference was defined as $p \leq 0.05$.

3. Results and Discussion

3.1 Moisture content variation

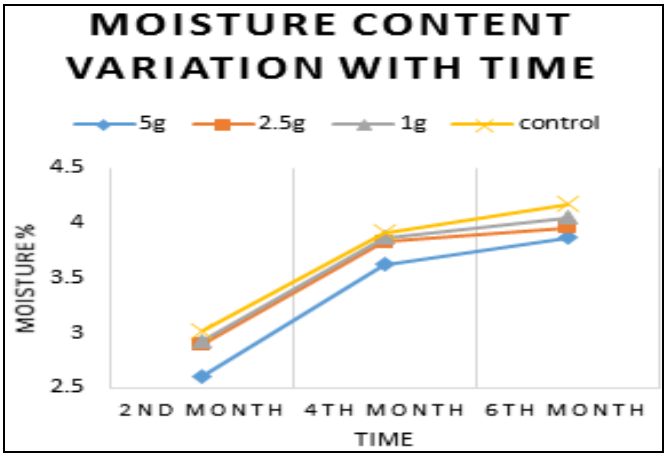

Fig 1: Moisture content variation of the four treatments is shown in

According to Figure 1, up to 4th month, there was an increased rate of moisture absorption by samples and thereafter the rate of moisture absorption has been decreased. Rice cracker 100g packed with 5g silica gel has been able to result lower moisture contents continuously throughout the 6 months. Moisture absorbance by hygroscopic food products directly results in loss of crispiness. According to Robertson 2006, dry food systems can lose their desired crispness during storage or upon opening of the package. Loss of crispness due to moisture uptake is a major cause of snack food rejection by consumers [11]. Therefore, to reduce the moisture absorption by crackers and to retard the organoleptic deterioration with

time, it was important to incorporate a necessary amount of desiccant inside the package. According to Figure 1, in order to get a 100g of crispy rice crackers with lower moisture content, the minimum amount of silica gel desiccant to be used is 5g for a desiccation property up to 6 months.

3.2 Texture variation

Table 1 can be used for further analysis of the relationship between the organoleptic deterioration of samples with time based on the variation of silica gel quantity. Table 1 shows the variation of sensory appeal in samples with time.

According to Table 1, rice crackers packed with 5g silica gel has gained a higher consumer preference in terms of appearance but the score was not significant at 0.05 significance level. Even though silica gel variation had an effect on moisture absorption in crackers, it had a very less effect on appearance of rice crackers up to 6 months. The crackers are somewhat hard in texture due to the incorporation of rice flour but according to the Table 1, absence of silica gel has not resulted a soggy or unappealing appearance in the control sample at the end of 6 months. Other than the silica gel, usage of oil also has an effect on the appearance of rice crackers. Repeated use of cooking oil also can cause changes in the physical appearance of oil, such as an increase in viscosity, color, and decrease smoke point oil and affect to the oil treated food [12]. But

Table 1: Rated mean values for sensory attributes of rice cracker samples during ambient storage

Sensory parameter	Treatment	2nd Month	4th Month	6th Month
Appearance	5g	4.43±0.51^{a}	4.29±0.64^{a}	3.95±0.59^{a}
	2.5g	4.14±0.72^{a}	4.10±0.70^{ab}	3.91±0.54^{a}
	1g	4.10±0.54^{a}	3.91±0.70^{ab}	3.81±0.68^{a}
	control	4.00±0.63^{a}	3.67±0.73^{b}	3.62±0.59^{a}
Odor	5g	4.71±0.46^{a}	3.91±0.54^{a}	3.81± 0.93^{a}
	2.5g	3.86±0.73^{b}	3.81±0.68^{a}	3.62± 0.67^{a}
	1g	3.76±0.70^{b}	3.76±0.77^{a}	3.52 ±0.60^{a}
	control	3.81±0.60^{b}	3.62±0.50^{a}	3.38± 0.87^{a}
Taste	5g	4.38±0.72^{a}	4.24±0.63^{a}	4.14±0.48^{a}
	2.5g	4.00±0.70^{ab}	3.86±0.57^{ab}	3.76±0.77^{ab}
	1g	3.91±0.83^{ab}	3.81±0.87^{ab}	3.57±0.68^{ab}
	control	3.76±0.70^{b}	3.57±0.93^{b}	3.43±0.93^{b}
Crispiness	5g	4.33±0.58^{a}	4.29±0.46^{a}	4.24±0.70^{a}
	2.5g	4.05±0.81^{ab}	3.86±0.73^{ab}	3.76±0.63^{ab}
	1g	3.96±0.67^{ab}	3.71±0.64^{b}	3.67±0.80^{b}
	control	3.43±1.12^{b}	2.86±0.91^{c}	2.62±0.59^{c}
Overall acceptability	5g	4.24±0.63^{a}	4.10±0.63^{a}	4.05±0.74^{a}
	2.5g	4.10±0.70^{a}	4.00±0.84^{a}	3.91±0.54^{a}
	1g	4.00±0.55^{a}	3.95±0.74^{a}	3.76±0.77^{ab}
	control	3.71±0.78^{a}	3.57±0.98^{a}	3.24±0.70^{b}

Different superscript letters at the same column for a particular sensory parameter indicate significant differences in the treatment. Data are presented as mean ± standard deviation (SD).

in this experiment oil is sprayed onto the crackers and sent for baking therefore oil is not repeatedly heated.

Preferable odor was reported in the sample packed with 5g silica gel but the score was not significant according to the statistical analysis at 0.05 significance level. With regard to the desiccation property of silica gel in rice crackers, production of off odors from hydrolytic rancidity can be retarded. Aldehydes, ketones, alcohols are some of the odorous volatiles made by hydrolytic rancidity. Off odors are made by several different volatiles and chemicals produced from chemical reaction as well as microbial activity. As an example aldehyde can be made from the breakdown of peroxides in the initial stages of fat oxidation in auto fat containing foods such as cereals and crackers. Overall, the deterioration of food usually consists of a series of events, which result in altered quality attributes, such as off-odors. Through reaction mechanisms, flavor precursors are converted to odorous volatiles **[13]**. According to the Table 1, odor of rice crackers was not significantly affected at 0.05 significance level from the variation of silica gel amount. From the beginning of evaluation, taste showed a significant difference in rice crackers packed with 5g silica gel whilst the control sample had gained a significantly least appeal in taste at 0.05 significance level. Variation of taste can be greatly affected by the purity of oil source, moisture absorption and oil rancidity in the case of crackers. Being effective as a desiccant, 5g silica gel amount had retarded the moisture absorption in 100g rice crackers and prevented the dilution of flavors therefore resulted in higher tasting appeal throughout the 6 months. At 0.05 significance level, crispiness has been resulted significant in rice crackers packed with 5g silica gel showing that 5g silica gel quantity was enough to result a good crispiness in 100g rice crackers up to 6 moths shelf life. Absence of an effective desiccant in the control sample had given the crackers to absorb high amount of migrated moisture through the packing material therefore it has resulted in a very low crispiness from the beginning up to 6 months. Food textural properties, such as crispness or crunchiness, are largely auditory sensations, and the product acceptability is often judged by the acceptable or expected sound level [14].

Taste and crispiness of a cracker is greatly correlated with each other. Zampini and Spence, 2010 [15] states that sounds made during eating can modulate people's perceptions of moistness, texture, and other aspects of food, and may

influence taste perception [15]. According to Neiva *et al*., 2011; Kyaw *et al*., 2001 [16, 17] crispiness of crackers is correlated with expansion and is also associated with the total amylopectin content of the flour or starch used. But for this experiment samples were prepared with the same batch of dough therefore those two reasons can be neglected [16, 17].

4. Conclusion

Non indicating silica gel is used as a food grade desiccant inside the hygroscopic rice cracker packets. This reduces the moisture absorption by rice crackers and retards its organoleptic deterioration. Results showed that the rice cracker 100g packed with 5g silica gel was able to result lower moisture levels throughout the 6 months of ambient storage. At 0.05 significance level, rice cracker 100g packed with 5g silica gel was able to result in significant taste, crispiness whilst resulting higher sensory score for the appearance, odor and overall acceptability. Thus 5g silica gel amount can be confirmed as the necessary amount of desiccant to be inserted in 100g rice crackers in order to protect the organoleptic properties up to 6 months of shelf life.

5. Acknowledgement

The authors are grateful to the academic and nonacademic staff of University of Sri Jayewardenepura, Sri Lanka.

6. References

1. Han JJ, Janz JA, Gerlat M. Development of gluten-free cracker snacks using pulse flours and fractions. Food Research International. 2010; 43(2):627-33.
2. Singh R, Singh G, Chauhan GS. Nutritional evaluation of soy fortified biscuits. J Food Sci. Technol. 2000; 37:162-164.
3. Katz EE, Labuza TP. Effect of water activity on the sensory crispness and mechanical deformation of snack food products. Journal of Food Science. 1981; 46(2):403-409.
4. Brody AL, Strupinsky ER, Kline LR. Active Packaging for Food Applications. Technomic Publishing Company, Inc. Lancaster, Pennsylvania, 2001.
5. Amarakoon AS, Navaratne S. Evaluation of the Effectiveness of Silica Gel Desiccant in Improving the Keeping Quality of Rice Crackers.
6. Sidel JL, Stone H. The role of sensory evaluation in the food industry. Food Quality and Preference. 1993; 4(1-2):65-73.
7. Hamilton PB. The chemistry of rancidity in foods. Sanders, TA, Nutritional Aspects of rancidity. Rancidity in Foods. (2nd ed.) Eds. Allen, J and Rancidity in Food. (2nd Ed.) Eds. Allen, J and Hamilton, RJ Elsevier Applied Science. London Washington, USA, 1989, 9.
8. Guinard JX, Mazzucchelli R. The sensory perception of texture and mouthfeel. Trends in Food Science & Technology. 1996; 7(7):213-9.
9. Meiselman HL. The contextual basis for food acceptance, food choice and food intake: the food, the situation and the individual. In Food choice, acceptance and consumption Springer US, 1996, 239-263.
10. Lawless HT, Heymann H. Sensory evaluation of food: principles and practices. Springer Science & Business Media, 2010, 27.
11. Robertson GL. Food Packaging Principles and Practice. Boca Raton, Florida: CRC Press. 2006; 61:417-446.
12. Rani AK, Reddy SY, Chetana R. Quality changes in trans and trans free fats/oils and products during frying. European food research and technology. 2010; 230(6):803-11.
13. Man CM. Shelf-life testing. Understanding and Measuring the Shelf-life of Food. 2004; 21:340.
14. Duizer L. A review of acoustic research for studying the sensory perception of crisp, crunchy and crackly textures. Trends in food science & technology. 2001; 12(1):17-24.
15. Zampini M, Spence C. Assessing the role of sound in the perception of food and drink. Chemosensory Perception. 2010; 3(1):57-67.
16. Neiva CR, Machado TM, Tomita RY, Furlan ÉF, Lemos Neto MJ, Bastos DH. Fish crackers development from minced fish and starch: an innovative approach to a traditional product. Food Science and Technology (Campinas). 2011; 31(4):973-9.
17. Kyaw ZY, Yu SY, Cheow CS, Dzulkifly MH, Howell NK. Effect of fish to starch ratio on viscoelastic properties and microstructure of fish cracker keropok dough. International journal of food science & technology. 2001; 36(7):741-7.