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Effect of maltodextrin and storage time on overall quality of wheat grass fortified rice cake

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Abstract

An attempt was made to study the effect of stabilizer (maltodextrin) on rheology, texture, moisture of rice cake on three different concentrations in 7 day storage period. 0.5%, 1% and 2%, of maltodextrin were added on total weight of the rice cake sample. Volume of rice cake is indirectly proportional to the percentage of maltodextrin in the rice cake. Rheological parameters were seen to increase on maltodextrin addition suggesting increase in rigidity of the samples. Maltodextrin has a good effect on texture improver during storage period. There is a relationship between moisture and hardness of the product. Color remains better than control sample during 7 days storage time.

Introduction

Wheatgrass is a tender small plant grown from wheat seed. It contains significant amount of protein, vitamins, minerals, phenolics and flavonoids (Das *et al*., 2011). Wheatgrass (8–10 days old) is increasingly being consumed in different forms by human beings as health supplement. It is also taken in the form of tablets which are commercially available. It has also shown antimutagenicity property (Peryt *et al*., 1992). Wheatgrass was also reported to be helpful in curing certain diseases such as thalassemia and distal ulcerative colitis (Ben-Arye *et al*., 2002; Marwaha *et al*., 2004). Chlorophyll, one of the active components in the wheatgrass extract, was found to be responsible for inhibiting the metabolic activation of carcinogens. Tender wheatgrass is a good source of trace elements also (Kulkarni *et al*., 2006). Texture is very important to determine various food product qualities. The texture of wheat grass fortified rice cake can be improved by using stabilizer. There are several types of stabilizer available in market which is used in food products. In bakery products the addition of xanthan gum improves the cohesion of starch granules, contributes to the structure and increases shelf-life due to moisture retention (Katzbauer, 1998). Maltodextrin is hydrolysis product of starch consisting of α-(1, 4) and α-(1, 6) linked D-glucose polymers or oligomers with a dextrose equivalent less than 20. The dextrose equivalent (DE) is a measure of the reducing power of starch derived polysaccharides/ oligosaccharides compared to D-glucose on a dry weight basis (Wang and Wang, 2000). Maltodextrin is digestive byproducts of starch that contain linear amylose and amylopectin degradation products (Kennedy *et al*., 1995; Chronakis, 1998). It is widely used in the food industry as stabilizers (texture and bulking modifiers) in food emulsions (Loret *et al*., 2004). Commercial maltodextrin of different dextrose equivalent values (DE 2-20) possess different physicochemical properties including solubility and viscosity. However, maltodextrin with the same dextrose equivalent may also possess very different physicochemical properties depending on the hydrolysis procedure and source/composition of the starch used in their preparation (Dokic-Baucal *et al*., 2004). Maltodextrin has multifaceted functions including bulking and film formation properties, binding ability of flavour and fat, reduction of oxygen permeability of wall matrix. However, its low glass transition temperature, leading crystals formation under increasing temperature may induce disruption of the structural integrity of wall matrix, and produce agglomeration or caking of micro particulate powders (Drusch *et al.*, 2006; Bae and Lee, 2008). Maltodextrin is not particularly surface-active, and so their main stabilizing action in oil-in-water emulsions is believed to be through viscosity

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modification or gelation of the aqueous continuous phase surrounding the oil droplets (Dickinson, 2003). Emulsions containing maltodextrin as stabilizers therefore require an additional emulsifying agent for the production of a stable emulsion (Hogan *et al*., 2001). In addition, molecular characteristics of maltodextrin, such as concentration and chain length, will affect the overall rheology and stability of oil-in water emulsions. Therefore, the principal objective of this study is to observe the effect of maltodextrin on the texture, colour and moisture content of wheat grass enriched rice cake during storage.

Materials and Methods

Raw materials

Rice flour (Vitarich agro food, India), sugar (Sakthi Sugar, India), salt (Tata salt, India), milk (Mother dairy, India), coconut milk (Nestle, India) were purchased from the local grocery stores at Jadavpur, Kolkata, India. Compressed baker's yeast (Saf Yeast Company Pvt., Ltd., Mumbai, India), Maltodextrin (HI Media, Mumbai).

Preparation of rice cake

The rice cake recipe consisted of rice flour 22%, sugar 20%, salt 3.5%, compressed baker's yeast 3.5%, wheat grass powder 1% and water 50%. In four different beakers, the dry ingredients, and the activated yeast, were taken in a beaker; requisite amount of water was added and then kneaded for approximately 10min until the dough was elastic and of required consistency. Maltodextrin was added each at three different beakers 0.5%, 1% and 2% on the 100gm total weight basis and one container is marked as control which is without maltodextrin. Then the beakers was covered with a cotton cloth and put in the incubator for 24 hours for 37ºC. After that the batter was poured into mould and steamed for 15-20 minutes. Then the rice cake was prepared & ready to serve. Rice cake with 0.5% maltodextrin denotes as sample 'A', with 1% maltodextrin denotes as sample 'B', with 2% maltodextrin denotes as sample 'C' & control which is only without maltodextrin denotes as sample 'D'.

Batter volume

The initial and final batter volume before and after incubation was noted and the % increase in volume is calculated using Nisha *et al.* 2005 (Nisha *et al.*, 2005).

Sensory analysis

Rice cake samples were coded and presented to 30 panel members for sensory scoring. The panel members, who were familiar with sensory analysis techniques, were postgraduate students and research scholars of the Department of Food Technology and Bio-chemical Engineering (Jadavpur University, India). Four sets of blend ratio samples were analyzed on separate occasions. Water was used for mouth rinsing before and after each sample testing. Each set contained one control (without maltodextrin) and the other three samples prepared with maltodextrin. Samples were scored for appearance, taste, color, texture, aroma and overall acceptability according to numerical scoring system. The model used in this analysis was an acceptance test on the hedonic scale, with values ranging from "1" (extremely disliked) to "9" (extremely liked). The sensory analysis data were subjected to statistical analysis. Mean and standard deviation were individually calculated for scores obtained for all quality attributes of each product.

Rheology

Rheological analysis was performed using a controlled stress rheometer (Anton Paar, Physica MCR 51, India) with parallel plate geometry (60 mm diameter). The batter was placed between parallel plates, the gap adjusted to 1 mm and the excess batter removed. To prevent drying at the edges, a thin layer of oil was applied to cover the exposed batter surfaces. Tests were performed at 20^0C. Oscillatory tests, with a frequency sweep from 0.1 to 10 Hz were conducted with a different aliquot of the samples. 5% stress is applied here. The dynamic rheological properties of samples were assessed by the storage modulus G' (elastic modulus), the loss modulus G" (viscous modulus).

Texture

Rice cake has a circular shape of approximately 7–10 cm diameter (depending on the mold size), flat with upper surface bulging, so that the product is thick at the center (2–2.1 cm). Texture of the rice cake was analysed by instron texture analyser (Instron Ltd., High Wycombe, Bucks, UK). The double compression test was done in the centre of the rice cake where the average thickness was 2–3 cm using probe in the normal mode at 10 mm/s up to a depth of 10 mm. Hardness (peak force of first compression cycle, Newton) was determined (Bourne 1978).

Color

Three replicates of color measurements were taken by the Hunter Lab color measurement system, Color Flex 45/0, D65, 10° observer (Hunter Associates Laboratory Inc., Reston, VA, USA). Hue

Table 1. Effect of different types of rice cake on variation of maltodextrin concentration in batter volume (%) and sensory property analysis

Sample	% increase of batter volume	Appearance	Taste	Overall acceptability	Color	Aroma
A	20.33±0.03^{a}	6.8±0.05^{a}	6.6±0.03^{a}	6.8±0.02^{b}	7.6±0.01^{a}	6.8±0.01^{a}
B	18.40±0.05^{b}	7.8±0.16^{b}	7.5±0.02^{c}	7.6±0.03^{d}	7.9±0.05^{b}	7.5±0.02^{d}
C	17.66±0.09^{c}	7±0.09^{c}	6.9±0.10^{b}	7.1±0.02^{c}	7.8±0.01^{b}	7.3±0.04^{c}
D	22.12±0.11^{d}	6.1±0.05^{d}	6.6±0.05^{a}	6.6±0.07^{a}	7.2±0.03^{c}	7±0.03^{b}

Rice cake with 0.5% maltodextrin denotes as sample 'A', with 1% maltodextrin denotes as sample 'B', with 2% maltodextrin denotes as sample 'C' and control denotes as sample 'D'. Means with the same superscript within the same column are not significantly different (p>0.05).

angle values were calculated by using Baysal *et al.* 2005; Heimdal *et al.* 1995 method.

Moisture content

Moisture content was measured by AOAC, 1984 method.

Statistical analysis

All the studies were replicated 3 times and the means were reported. Data represents means of three samples analyses (n=3) + standard deviation. All the experimental data were analyzed statistically for analysis of variance (ANOVA) with Microsoft Excel 2007. Means were compared by Fisher's least significant difference test at a significance level of $p \leq 0.05$ (Gacula and Singh 1984).

Results and& Discussion

Batter volume and sensory analysis

Yeast is used as a leavening agent. Volume expansion of yeast-leavened rice cakes correlates positively to the amylose content of the batter. Amylose slowed the viscosity increase during cooking and delayed the time of setting of the batter, thus helping in the retention of the expanding gas bubble before the batter becomes a cake (Mohamed *et al*., 1995). Percent increase in volume of rice cake in sample A, B, C, D are shown in table 1. Volume is indirectly proportional with concentration. As the other material are same, so the concentration of maltodextrin if increase the volume of batter is decreased. It is observed in sample D batter volume increases 22.12%, where as in sample B, C, D batter volume increases 20.33%, 18.40% and 17.66 respectively. Maltodextrin exhibit higher viscosities whose DE are greater than 20 and are thus preferred with respect to cohesive and foam stabilizing properties for specific applications (Wang and Wang 2000).

Sensory property is very important for accepting, selling and marketing of the product. Sensory data of the acceptance level of different rice cake samples are presented in table 1. Conventionally, panelists prefer rice cake with one percent maltodextrin and fortified by 1% wheat grass. By hedonic scale sensory property is analyzed. It is observed that color, appearance, taste, aroma and overall acceptability is highest in sample B than sample A, C, D respectively. It is observed in Figure 2. that hardness of sample B is less than other samples. Hardness of a food product affects the acceptance of the sample. Here members prefer color of sample B than other samples. Wheat grass is useful towards fortification of rice cake with maltodextrin. The addition of natural herbs and maltodextrin enhances moisture retention capacity, slows staling rate, and gives rich antioxidant content, and improved sensory properties in terms of color, texture, appearance and overall acceptability.

Rheology

The viscoelastic behaviour of gluten-free dough samples was investigated by oscillation frequency sweep experiments conducted in the linear viscoelastic range. Storage (G') moduli was higher than G" through all the frequency range (1-10 Hz), showing only slight increase with increasing frequency, which is typical gel like behaviour (Korus *et al.*, 2012). At relatively low maltodextrin concentrations the relative viscosity was slightly higher than unity across the whole shear stress range, at higher maltodextrin concentrations the relative viscosity was much greater than unity at low shear stresses, which can be attributed to extensive droplet flocculation (McClements 1999; Quemada and Berli 2002). In other words, flocculation occurred at lower maltodextrin concentrations as the molecular weight of the maltodextrin molecules increased. From

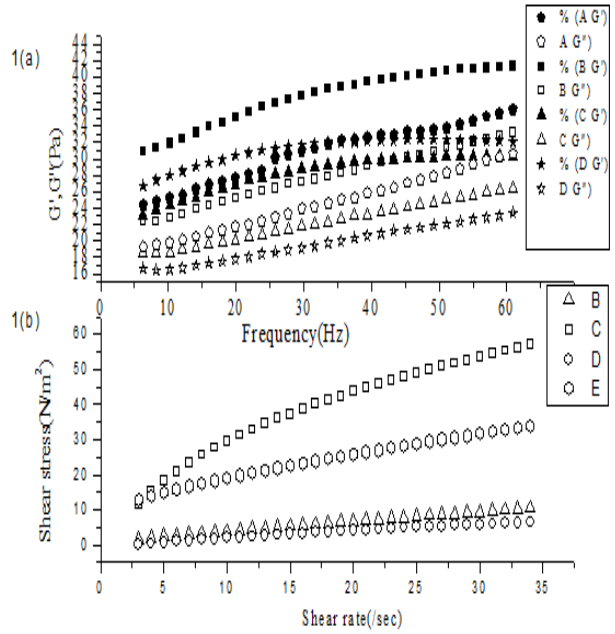

Figure 1. (a) Viscoelastic properties of different types of rice cake at 20°C, (b) Variation of shear stress with shear rate on different types of rice cake at 20°C.
Rice cake with 0.5% maltodextrin denotes as sample 'A', with 1% maltodextrin denotes as sample 'B', with 2% maltodextrin denotes as sample 'C' and control denotes as sample 'D'.

Figure 1 (a). it was observed that in sample B, the viscoelastic property was higher than sample A, C, D. As it is well known, the yield stress represents the minimum stress required to initiate the material flow and thus it represents the measure of the strength of the material structure (Tárrega *et al*., 2006). Figure 1 (b). Represents variation of shear stress with shear rate in different types of rice cake by coconut milk at different percentage of maltodextrin. It was observed that if concentration of maltodextrin was increased, the stress requirement was high for the material flow, in sample D; stress was higher than sample A, C, B.

Texture

Texture was closely related with overall quality. Since there was no difference in chemical composition between the samples, the differences in texture could be explained by the microstructure and by the characteristics of the maltodextrin used. Emulsifier content above 3% in yeast leavened rice cake caused the texture to become too crumbly. Hardness of the product is indirectly proportional to the batter volume and volume of the product. Lesser degree of fermentation is responsible for increased hardness. In Figure 2. it was observed that in storage period the texture of rice cake with maltodextrin become stiff & hard. Fermentation is inversely proportional with hardness. It was also observed that in sample A, the hardness at 0 day is 3N, and at 7 day it is 5.1 N, So

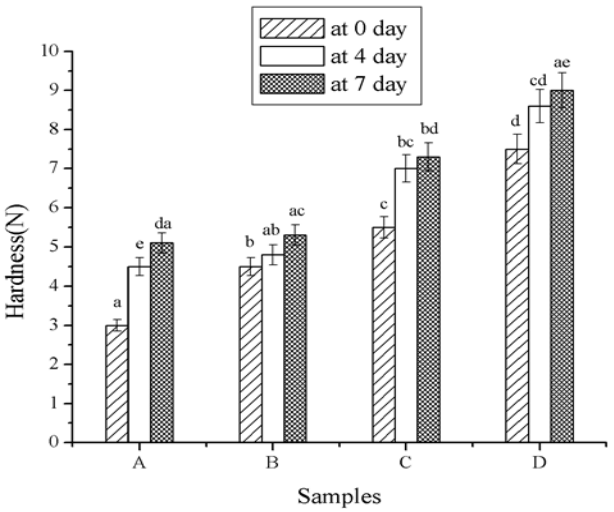

Figure 2.The hardness of different samples in storage period of 7 day.
Rice cake with 0.5% maltodextrin denotes as sample 'A', with 1% maltodextrin denotes as sample 'B', with 2% maltodextrin denotes as sample 'C' & control denotes as sample 'D'. Bars with the same letter are not significantly different at $p < 0.05$ based on Fisher's least significant difference test.

the hardness of A is lower than other samples in 0 day as well as 7 day storage period. The hardness of sample B, C, D at 0 day is 4.5 N, 5.5 N, and 3.2 N respectively and at 7 day storage period the hardness of sample B, C, D are 5.3N, 7.3 N, 7.3N. In sample A fermentation was high, so the product was softer than other samples during 7 day storage.

Color

The color of the rice cake is a characteristic first perceived by the consumer, and affects the acceptability of the product. The effect of addition of different percentage of maltodextrin on the visual color of rice cake was exhibited in Figure 3. It was observed that hue angle was decreased with the addition of maltodextrin. After seven days storage period color of the rice cake with maltodextrin became intact almost, little browning occurs. It was observed that comparatively in sample B color is same in zero day as well as 7 day storage period.

Moisture content

Moisture content of food measures mainly the water content of the food sample. To determine the final quality of the food, moisture content is very important. The correlation between hardness and moisture content was represented in Figure 4. From Figure 4(a), (b), (c), (d) it was observed that on 1 day storage in sample A, the moisture evaporation is very less than other sample. In sample C and sample D moisture evaporation is high than sample A and sample B. so sample C and D were very dry in nature.

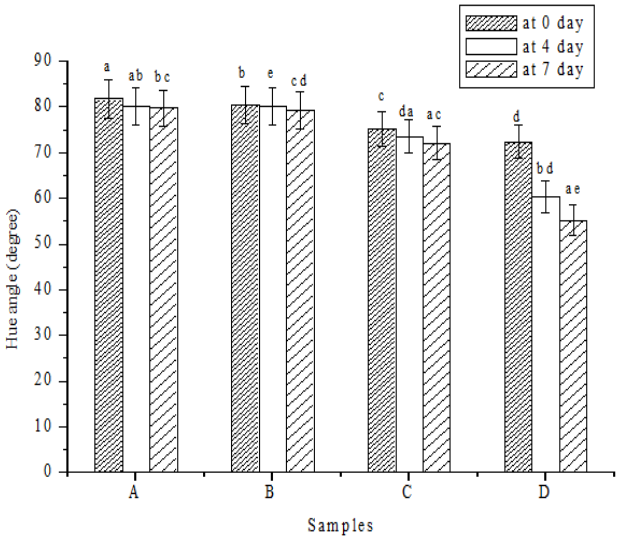

Figure 3. Color differences in different samples in storage
Rice cake with 0.5% maltodextrin denotes as sample 'A', with 1% maltodextrin denotes as sample 'B', with 2% maltodextrin denotes as sample 'C' and control denotes as sample 'D'. Bars with the same letter are not significantly different at $p < 0.05$ based on Fisher's least significant difference test.

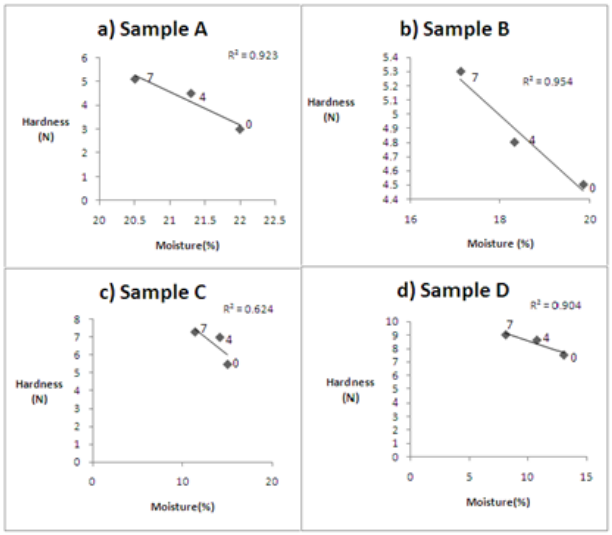

Figure 4. Corelation between hardness and moisture content of different samples in storage
Rice cake with 0.5% maltodextrin denotes as sample 'A', with 1% maltodextrin denotes as sample 'B', with 2% maltodextrin denotes as sample 'C' & control denotes as sample 'D'. 0 represents reading at 0 day, 4 represents reading at 4 day and 7 represents reading at 7 day.

During 7 day storage period in sample B hardness (5.5N) was less than other samples, moisture evaporation is less in sample B than other products, so better quality sample than other three types. From the Figure 4(b), it was observed that corelation ratio is 0.954 in sample B, which was higher than other samples. So the texture quality of product B was better than other samples. Much water content of the sample affects texture of the product and causes bacterial growth.

Conclusion

It can be concluded that supplementation of maltodextrin is a new approach that it is a very easily digestible sugar, but its concentration should be adequate. Maltodextrin will convert to blood sugar or wind up stored as fat faster than other sugar. Maltodextrin is a useful additive too. From this study it can be concluded that on batter property there is no effect of stabilizer concentration. But when product is ready, it was found that addition of stabilizer, i.e maltodextrin significantly affect parameters like texture, color and moisture content. In sample A, the hardness at 0 day is 3N, and at 7 day it is 5.1 N, The hardness of sample B, C, D at 0 day is 4.5 N, 5.5 N, 7.5 N respectively and at 7 day storage period the hardness of sample B, C, D are 5.3N, 7.3 N, 9N. Hardness is comparatively high in other samples than in sample B. After seven days storage period color of the rice cake with maltodextrin become same as well as 0 day storage period. Sample B is best in texture, moisture content and color retention during storage. The panel members score for overall acceptability in sample A, B, C, D are 6.8, 7.5, 7.3, 7.0. The taste panel members also prefer sample B than other three types.

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