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Effect of hydrocolloid (xanthan gum) and Storage time on overall Quality of Cocoa incorporated Fermented Food

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Abstract

The study consists of the effect of xanthan gum on overall quality of cocoa enriched fermented food during storage time. The four different concentration of xanthan gum was used 0%, 0.5%, 1% and 2% in this research study. Texture profile analysis (hardness, cohesiveness, chewiness and springyness) was done during storage time. Texture profile analysis suggested that addition of xanthan gum hardness will increase and after 21days storage, 1% incorporated xanthan product, hardness is less than other samples. After storage chewiness and cohesiveness were increased and springyness was decreased. After addition of xanthan moisture content was decreased and at 1% xanthan addition after storage of 21 days moisture content degradation less is minimum than other samples. L value was increased after addition of xanthan and after storage it was decreased. Appearance score was increased after addition of xanthan but with respect to overall acceptability 1% xanthan incorporation score was highest.*

Keywords: Hydrocolloid, Xanthan gum, texture, color, moisture content.

Introduction

Hydrocolloids are water-soluble, high molecular weight polysaccharides which are used in food industry to enhance viscosity, create gel-structures, film formation, control crystallization, inhibit syneresis, improvement of texture, to encapsulate flavors and lengthen the physical stability[1-4]. There are several types of hydrocolloids available in market which is used in food products. Many researchers focused about the influence of hydrocolloids on the rheological characteristics of dough and the quality characteristics of bread, cakes and flat breads like chapati and tortilla. Guarda *et al.* observed the effect of hydrocolloids such as sodium alginate, k-carrageenan, hydroxyl propyl methylcellulose and xanthan gum on the bread quality characteristics and proved that water absorption was increased by the hydrocolloids incorporation[5]. In proofing of the wheat dough, hydrocolloids i.e sodium alginate, k-carrageenan, xanthan gum and HPMC were incorporated for dough improvement[6]. A study with locus bean, xanthan gum and alginate revealed a softening effect of those hydrocolloids, due to the high water retention capacity in the case of locus bean, or for hindering the gluten-starch interactions in the case of xanthan gum and alginate[7]. Hydrocolloids themselves have a low calorific value and are generally effective in small quantities[8-10]. The hydrocolloids are classified as either food additives or generally recognized as safe (GRAS) substances by the United State Food and Drug Administration[11].

Guar gum, xanthan gum and carboxy methyl cellulose are good thickeners and increase consistency of tomato ketchup[12]. When emulsifiers like glycerol monostearate (GMS), sodium stearoyl lactylate (SSL) are intaracted with oxidized starches like oxidized white sorghum starch (which are used in food products like sauces, spreads, mayonnaise, breads, cakes, etc), gels are soften, rigidity of gels is reduced and thickening power is increased[13]. Xanthan gum enhances protein adsorption the emulsion stability was increased[14].

In oil drilling fluids and in enhanced oil recovery xanthan gum was used to control water and stabilize the suspension under extreme conditions like temperature and high salt concentration[15]. In bakery products xanthan gum improves the starch granules cohesion, structural improvement and shelf-life enhancement due to moisture retention[16]. Mettler and Seible[17] and Shittu et al.[18] observed the use of carboxy methylcellulose, guar gum and xanthan on rye bread and cassava bread to improve their quality and shelf life enhancement of food products. As xanthan gum in noodles samples produced from unripe plantain flour increased there was an improvement in their smoothness, firmness, stickiness and starchy mouth coating and also color and texture, 3.5% xanthan gum was highly accepted[19]. Xanthan gum was more effective to increase elasticity, to increase L value for crumb and crust and to decrease hardness in gluten-free bread[20]. The xanthan-derived oligosaccharides show high hydroxyl radical scavenging activity[21]. Xanthan gum was used to create Tapioca starch based products with better rheological property and freeze thaw stability during product development in food industry[22]. In blueberry puree xanthan gum is a very important variable of the rheological study[23].

Therefore, the principal objective of this study is to observe the effect of xanthan gum on the quality control, texture, moisture content, color of chocolate enriched barley and oat based fermented food during storage.

Material and Methods

Raw Materials: Given below is the list of the ingredients used with company from which they were in brackets. Barley (Vitarich agro food Ltd, India), Oat (Kellogs, India), sugar (Sakthi Sugar, India), salt (Tata, India), coconut milk (Nestle, India), baking powder and chocolate powder (Weikfield Foods Pvt Ltd, Nalagarh, India).

Chemicals: Xanthan gum (HI Media, India).

Processing: The recipe batter is prepared in four bowls. It is consisted of barley flour 16%, oat 7%, cocoa powder 2%, sugar 20%, coconut milk 6%, salt 2%, baking powder 5% and water 42%. Mixing of all the ingredients was done manually until the dough was in consistent nature. Xanthan was added each at three different beakers 0.5%, 1% and 2% on the 100 gm total weight basis and one container is marked as control which is without xanthan. Then the bowls were covered with lid and put in the incubator for 24 hours at 37ºC. Then the batters were steamed in micro oven (Samsung, India) for 15 minutes. Then it is cut into square pieces. The fermented food samples thus were prepared and were ready to serve. Chocolate fortified barley oat based fermented product with control (without xanthan) denotes as sample A, sample 0.5% xanthan denotes as sample ' B', with 1% xanthan denotes as sample 'C' and with 2% xanthan denotes as sample 'D'.

Product analysis: Texture: The fermented food samples were square shaped. Texture of the food samples was analyzed by instron (TA.HD Plus Texture Analyzer, USA). The double compression test was done and texture profile analysis (TPA) curve is obtained. An aluminum cylindrical probe was poured in the centre of the food samples where the average thickness was 2–3 cm at 10 mm/s speed. Hardness, cohesiveness, gumminess, chewiness were calculated from the TPA graphic. Hardness, springiness, cohesiveness, chewiness were calculated[24].

Color: The color (L*a*b*) measurement of food products was done by Hunter Lab colorimeter system (Color Flex 45/ 0, D 65, 10° observer; Hunter Associates Laboratory Inc. Reston, VA, USA). Samples were put in optical glass cells 3.5 cm in length and 6 cm diameter. L* express lightness (0; black to 100; white), a* express redness (−; green to +; red), and b* express yellowness (−; blue to +; yellow) values. Chrome (C*) is a very useful parameter to determine color, $C^* = (a^2+b^2)^{1/2}$. Hue angle (h*) denotes the difference of color with grey color. Hue angle (h*) was observed by $h^* = 1/\tan(b^*/a^*)$. The equation and the color measurement followed the procedures outlined by Granato and Ellrndersen, 2009[25]. Each sample was measured in three times.

Moisture content: Moisture content was measured by AOAC, 1984 method[26].

Sensory Analysis: Fermented food samples were coded and given to 30 panel members for sensory analysis. The panel members were postgraduate students and research scholars of the Food Technology and Bio-chemical Engineering Department (Jadavpur University, India). They were familiar with sensory testing. Water was used for mouth rinsing before and after each sample testing. One sample which was prepared without xanthan and the other three samples prepared with xanthan gum in different concentration were given to each panel member for sensory scoring. Samples were analyzed for appearance, taste, color, and overall acceptability. Hedonic scale (ranging from 1 to 9) was used for sensory measurement of the samples. Extreme dislike was denoted by "1" and extreme like was denoted by "9".

Statistical analysis: Studies done were replicated three times and the means were reported. Analysis of variance (ANOVA) was calculated in Microsoft Excel 2007 for experimental data analysis. Comparison of Means were done by Fisher's least significance difference test at $p \leq 0.05$.

Results and Discussion

Texture: Texture is a very important parameter to measure food quality and appearance of food to buyer as well as seller. The texture was influenced microscopic level of food structure as well as macroscopic composition of food[27]. Texture is related to sensory score and interior construction of food ingredients [28-29]. Therefore, texture is actually defined by some mechanical properties, i.e hardness/firmness, gumminess, resilience, cohesiveness, springiness, adhesiveness[30]. Food texture was also measured by the addition of hydrocolloids in processed food products. Hydrocolloids has many function in foods, such as thickening, gelling, water holding, dispersing, stabilizing, film forming, and foaming, and have been used as a texture modifier in almost every kind of processed food products, including mayonnaises, dressings, dessert jellies, ice creams etc. Hardness, cohesiveness, springiness and chewiness were observed in figure 1(a), 1(b), 1(c) and 1(d). It is observed from figure 1(a) that after addition of hydrocolloid hardness is increased gradually. In sample A (without xanthan) hardness is 3.2 Newton, when 2% hydrocolloid is added hardness is 4.3 Newton. In sample A, after storage of 7days hardness is 5.6 Newton and after 21days hardness is 8.32 Newton. In sample B, C and D after 21days hardness is 8N, 7N and 7.4N respectively. Comparatively after 21 days storage, hardness of sample C is less than other samples, it may be due to at 1% level of xanthan gum moisture evaporation is less, and sample C is softer than other samples after 21 days storage. At lower level of incorporation (<1 %), hydrocolloids improve the quality of baked goods[31]. It is observed in figure 1(b) that after hydrocolloid addition cohesiveness is increased. Addition of xanthan gum at 0 day cohesiveness increases gradually, after 21 days of storage cohesiveness of sample B, C and D.

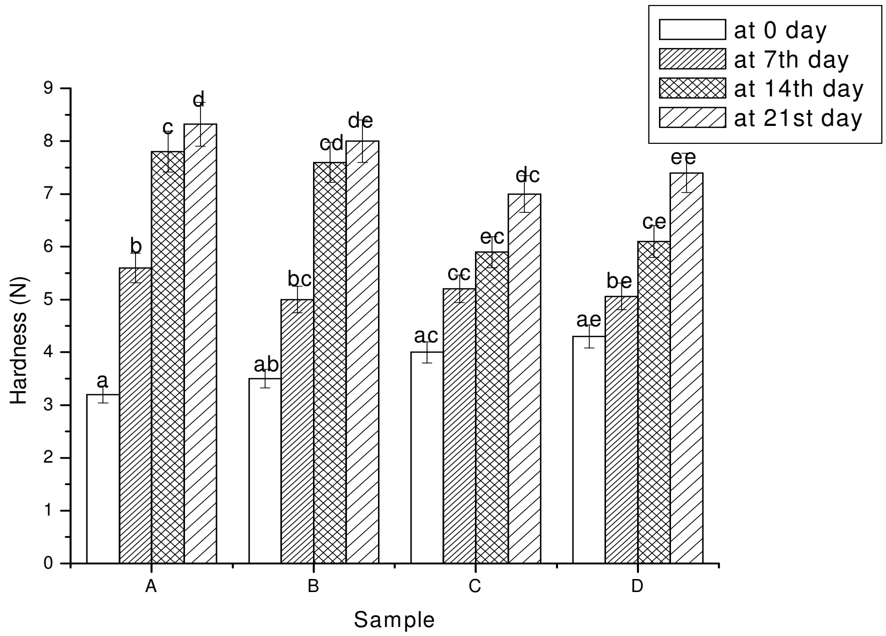

Figure-1(a)
Hardness of different samples in storage period

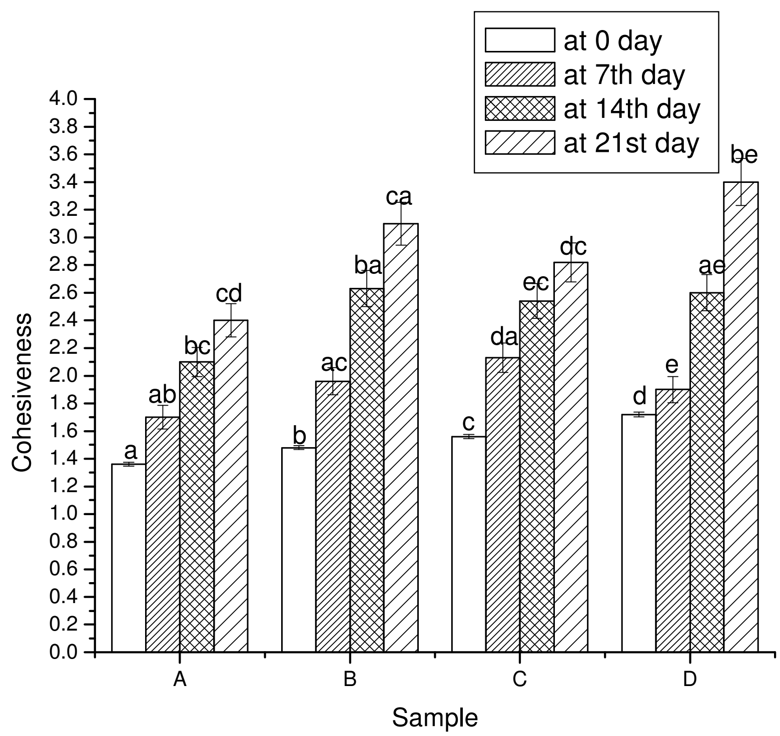

Figure-1(b)
Cohesiveness of different samples in storage period

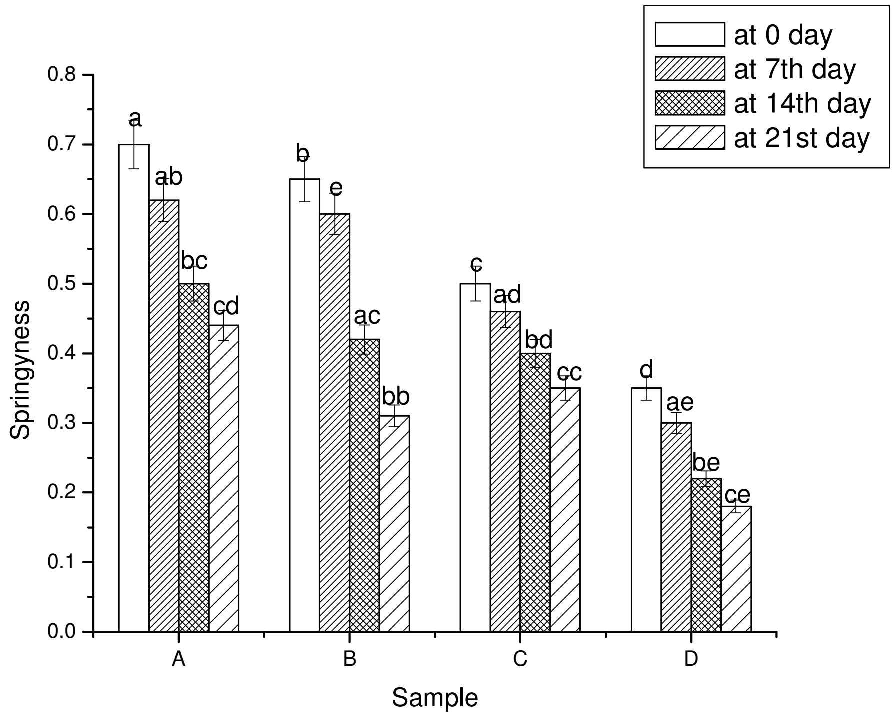

Figure-1(c)
Springyness of different samples in storage period

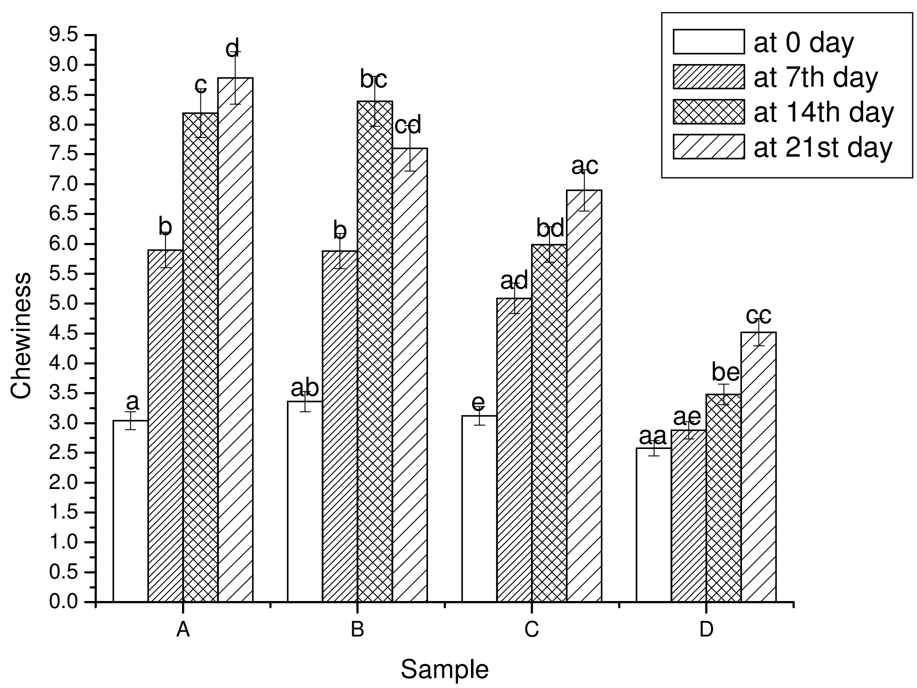

Figure-1(d)
Chewiness of different samples in storage period

Chewiness is a useful texture parameter which was related with trained panelist"s sensory score[32]. Lower the chewiness the product is softer. It is observed in 1(d) that in sample A, chewiness is 3.04, after 21 days chewiness is 8.78. At 0 day storage chewiness is higher than other samples but after 21 days storage chewiness is 7.6, whereas in sample C and sample D chewiness is 6.9 and 4.52. In sample D, chewiness is too lower to consume the product and its overall acceptability is very less than other samples and it is depicted in figure-4.

It is observed in 1(c) that springiness is lower in storage period. Day by day springiness is decreased & product becomes hard. The springiness in sample A, B, C and D are 0.7, 0.65,0.5 and 0.35 but after 21days storage the chewiness of sample A, B, C and D are 0.44, 0.31, 0.35 and 0.18. Comparatively after storage the chewiness of sample C is better than sample B and sample D. Increase concentration of xanthan, chewiness will decrease and it depicts in figure-1(d).

Color: The color of the product sample is a characteristic first perceived by the consumer, and affects the acceptability of the product. Hue value is very effective for determine the color of food sample [33]. Figure-2 represents the L* value degradation characteristics on effect of addition of different concentration of xanthan gum in food samples. It is observed that L* value increases with higher percentage of xanthan gum concentration in food samples at zero day. In storage L* value of sample C was less degraded than other samples. R^2 value was represented in figure-2. After storage degradation rate is maximum in sample A. It is observed in table-1 that after addition of xanthan gum in food products hue angle and chrome will increase and during storage hue and chrome were decreased. At 0 day hue angle range between 70.27-79.7 and after storage its ranges within 57.3-69.4.

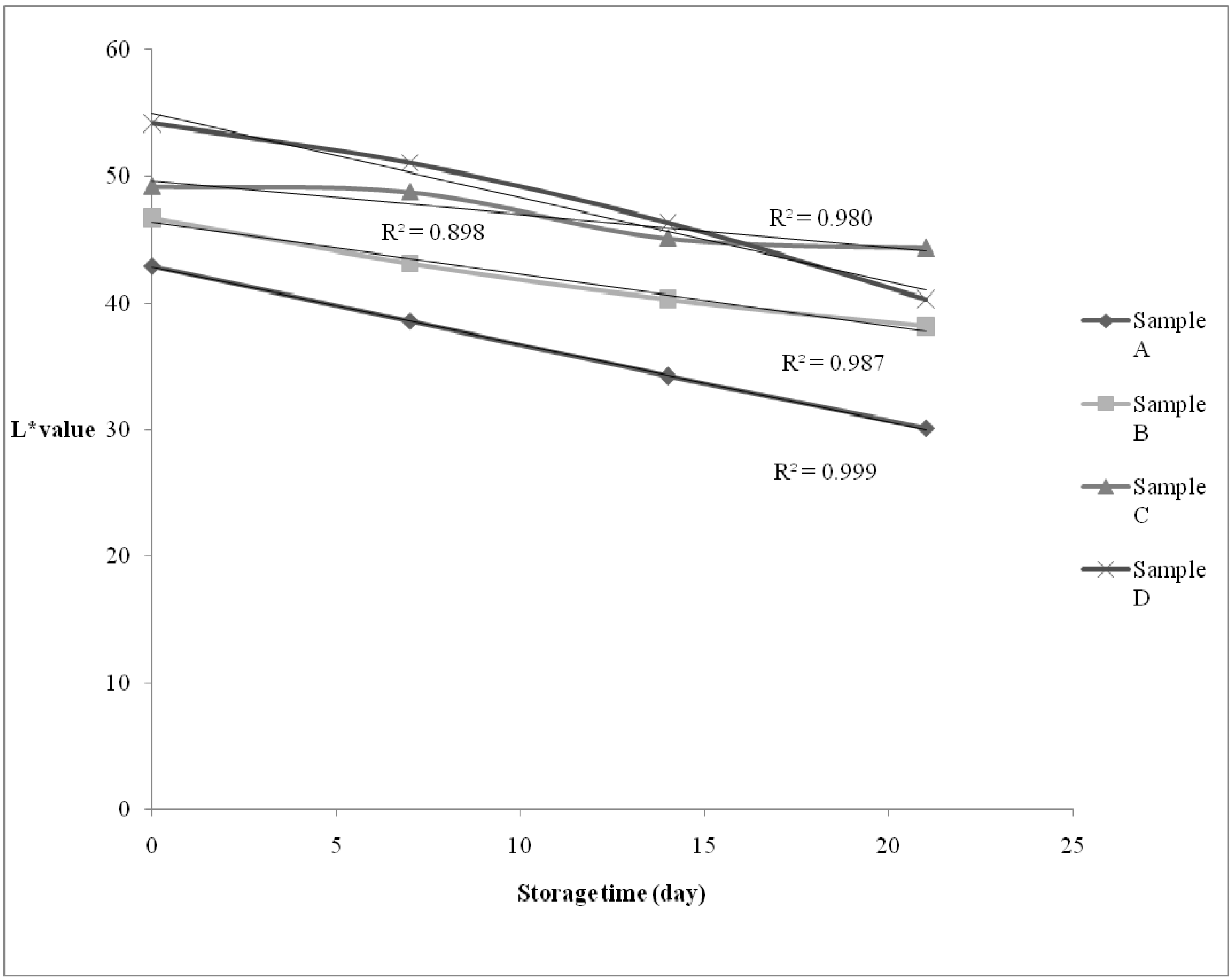

Figure-2
L* value degradation of different samples in storage period

Chocolate fortified barley oat based fermented product with control (without xanthan) denotes as sample A, sample 0.5% xanthan denotes as sample ‘ B’, with 1% xanthan denotes as sample ‘C’ and with 2% xanthan denotes as sample ‘D’.

Moisture content: Moisture content is a very important property to determine food qualty. 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 effect of incorporation of xanthan on moisture content in fermented food product was represented in figure-3. Figure-3 represents addition of hydrocolloid moisture content decreases gradually; at 0% level of xanthan at 0 day moisture content is 16.23% but when the food product is incorporated with 2% xanthan then the moisture content is 14.15%. With addition of hydrocolloids, the moisture content decreased, as hydrocolloids prevent syneresis and improve the properties of gel,[34, 35]. In sample B, after storage moisture content is less than sample A. In storage moisture content is decreased but in sample C, moisture content degrade rate is minimum than other samples. At 0 day in sample C moisture content is 14.87% and after storage moisture content is 11.65%. In sample D, after 21 days storage moisture content is 9.43% which is very hard in texture and as overall acceptability is related with moisture content, so overall acceptability is very low in sample D after 21 days storage.

Sensory analysis: Sensory property is very important for accepting, selling and marketing of the product. Sensory score of different samples were observed in figure-4. Conventionally, panelists prefer sample C with 1% xanthan. By hedonic scale sensory property (appearance, taste, color and overall acceptability) is analyzed. With respect to appearance, concentration of xanthan gum increase, better appearance was obtained. In respect of taste, 1% xanthan gum incorporated sample has highest taste, 0.5% addition of xanthan gum produces less taste than sample and 2% xanthan incorporation taste score is lowest (6.6) among other samples. Hardness influences taste, after storage sample D is very hard in nature, so taste quality is poor. In respect of color sample C had highest score. 1% xanthan addition in food samples, very less browing occurred. In terms of overall acceptability sample A had highest score and 0.5% (B) and 1% (C) addition of xanthan the overall acceptability score is satisfactory but in sample D, the overall acceptability score is 6.5.

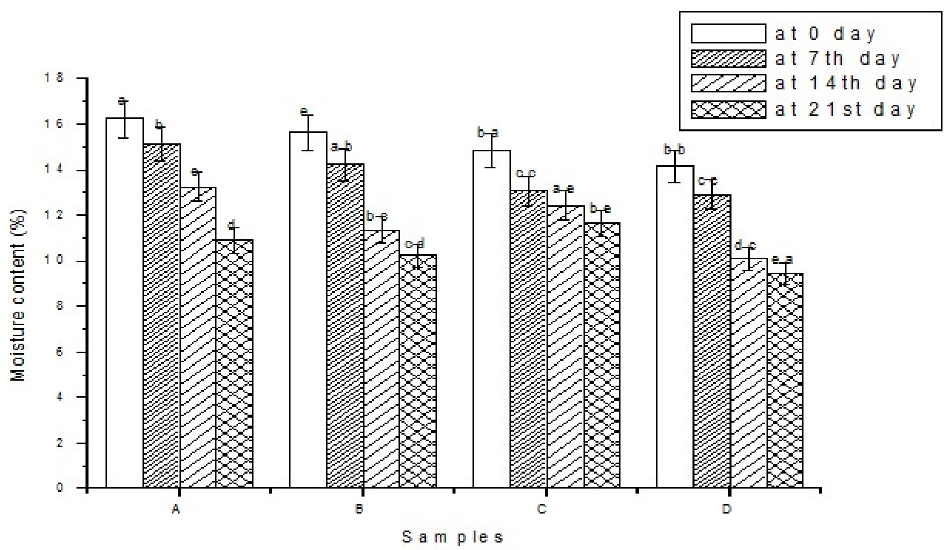

Figure-3
Chocolate fortified barley oat based fermented product with control (without xanthan) denotes as sample A, sample 0.5% xanthan denotes as sample ‘ B’, with 1% xanthan denotes as sample ‘C’ and with 2% xanthan denotes as sample ‘D’

Table-1
Hue angle and chrome in different food samples in storage period

Sample	Hue Angle (°)				Chrome			
	0 day	7th day	14th day	21st day	0 day	7th day	14th day	21st day
A	70.27±0.02[a]	65.26±0.03[ab]	60.1±0.06[aa]	57.3±0.09[e]	15.94±0.02[a]	11.44±0.08[ab]	10.9±0.03[e]	8.2±0.03[dd]
B	73.2±0.03[b]	70.11±0.01[bc]	67.8±0.09[bd]	66.09±0.05[de]	16.37±0.03[b]	14.4±0.05[bc]	13.02±0.02[aa]	11.7±0.06[ba]
C	77.4±0.01[c]	75.2±0.005[cd]	73.06±0.02[ad]	71.1±0.01[ce]	18.28±0.04[c]	15.33±0.05[cd]	14.92±0.07[bb]	13.37±0.09[ca]
D	79.7±0.05[d]	76.34±0.06[de]	72.1±0.04[be]	69.4±0.03[ee]	21.37±0.09[d]	19.02±0.04[de]	16.32±0.1[cc]	14.99±0.11[da]

Chocolate fortified barley oat based fermented product with control (without xanthan) denotes as sample A, sample 0.5% xanthan denotes as sample ‘ B’, with 1% xanthan denotes as sample ‘C’ and with 2% xanthan denotes as sample ‘D’.

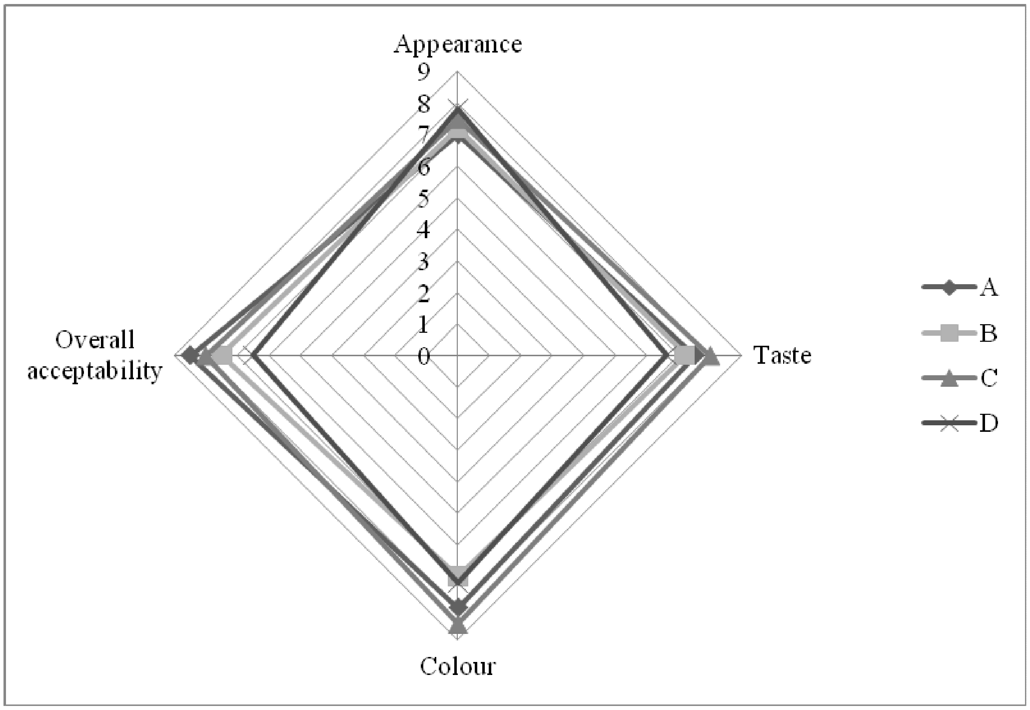

Figure-4
Effect of food products on variation of xanthan gum concentration on sensory property
Chocolate fortified barley oat based fermented product with control (without xanthan) denotes as sample A, sample 0.5% xanthan denotes as sample ‘ B’, with 1% xanthan denotes as sample ‘C’ and with 2% xanthan denotes as sample ‘D’.

Conclusion

The addition of xanthan gum was found to improve texture characteristics, moisture content, color profile and sensory property of food samples and increase shelf life in storage period. Xanthan is a texture improver and when its concentration is 1%, after 21 days its hardness is better than other samples. After storage chewiness and cohesiveness will increase and springiness will decrease. Higher amounts of xanthan gum decreases moisture content. After 21 days in sample C, moisture degradation rate is lower than other samples. Degradation of L* value is maximum in sample D and minimum in sample C, so browning is less in sample C. After addition of xanthan hue angle and chrome were increased and after storage hue angle and chrome were decreased. Sample C has highest score in overall acceptability because its taste score is higher than other samples, after storage its moisture degradation rate is minimum than other samples, less browning was occurred, so L value degradation rate is less than other samples.

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