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Investigation on the Effect of Carboxymethyl Cellulose and Carrageenan on the Rheological, Physicochemical and Sensory Characteristics of Chocolate Drink Powder

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ABSTRACT

Gums and thickeners are the main ingredients used in chocolate drinks. In this study, the effect of adding different concentrations of carboxymethyl cellulose (0, 0/5, 1 and 2%) and Carrageenan (0, 0/25, 0/5 and 1%) on the viscosity, physicochemical and sensory properties of beverages chocolate has been investigated. The results showed that both of the thickeners were improved viscosity. But changes in the physicochemical characteristics of the samples are compared with each other and control samples were not significant. Sensory evaluation also showed that addition of thickeners to improve overall admission relative to the control sample.

KEYWORDS: Carboxymethyl cellulose, Carrageenan, Chocolate drink, Viscosity

1- INTRODUCTION

Chocolate drink powder is product of then mixed with water or milk is used. Cocoa, sugar, milk powder and other additives are ingredients of chocolate drink powder. The disadvantage of these drinks is that particles of cocoa, the precipitate formed at the bottom of the container, after the initial stirring, quickly [1]. Hydrocolloids are complex combinations that are used for texture modification, crystallization control, prevent of product leakage or syneresis, covering the aromas and tastes, increased physical stability, film formation, gel formation and increase consistency in food products liquid and semi-liquid. Many of them are not metabolized in the human body and energy (calories speciation) is low. Hydrocolloids do not direct effect on the flavor and taste of food, but affected on the gel formation, maintenance of water, emulsion formation and maintenance of aromas and tastes [2, 3].

Investigations were conducted about the effect gums and thickeners in cocoa and chocolate drinks. Dogan et al. 2011, studied on optimization of gum combination in prebiotic instant hot chocolate beverage. In this study mixture design was used to investigate the effects of four different gums (xanthan gum, guar gum, alginate and locust bean gum) and their combinations on the rheological properties of a prebiotic model instant hot chocolate beverage (including 3.5% inulin) and to determine their interactions in the model beverage. In the model, the optimum gum combination was found 59% xanthan gum and 41% locust bean gum. The increase of guar gum and alginate in the gum mixture caused a decrease in the K value of the sample [4].

Tuason et al. 1990, studied on microcrystalline cellulose-based stabilizer system for dry mix instant chocolate drink. Dry powder stabilizing agent useful for suspending cocoa solids in dry mix instant chocolate drink formulations that is reconstituted with hot water. The stabilizing agent is a coprocessed, codried powdered composition containing colloidal microcrystalline cellulose, a minor amount of starch, and a non-thickening water-soluble diluent such as maltodextrin, whey or non-fat dry milk [1].

Pascual et al. 2011, studied on ready to drink beverages. A ready to drink beverage is including water, a cocoa component, and a stabilizing system. The stabilizing system has a cellulose component including a blend of microcrystalline cellulose and carboxymethyl cellulose in an amount ranging from about 0.03% to about 1% by weight, a gum, and an emulsifier ranging from about 0.09% to about 10% by weight [5].

Carboxymethyl cellulose[1] and carrageenan are from the most important thickeners and stabilizers used in chocolate drinks to increase stability, reduce sediment and tissue formation in products. Cellulose derivatives such as carboxymethyl cellulose are one of the most edible gums [6, 7]. Carboxymethyl cellulose is from the Hydrocolloids and cellulose derivatives which have been used in the food industry and other industries as stabilizer, thickener, suspension, and maintenance of water extensively [2, 8 & 9].

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Carrageenan is from polysaccharides that obtained from marine algae. Different carrageenans have different rheological properties from a combination of viscous to gel and from textural from soft tissues and elastic to hard and brittle. All carrageenan are soluble in hot water [10]. The most stabilizer materials that have been used in chocolate milk are kappa-carrageenan and sodium alginate which effect of kappa-carrageenan in increase viscosity and sensory properties from sodium alginate was better [11, 12]. Therefore, considering the importance of thickeners and stabilizers in these products, this study examines the behavior of different concentrations of carboxymethyl cellulose and carrageenan in the food system of chocolate drink.

1- CMC

2- MATERIALS AND METHODS

1-2- Raw materials

Raw materials required for the production of chocolate drink powder was prepared in accordance with Table 1.

Table 1. Raw material

Materials	Supplier	Country
Cocoa powder	Altinmarka	Turkey
Sugar	Neyshaboor	Iran
Salt	Solvan	Iran
Xanthan	Danisco	Denmark
Carrageenan	Danisco	Denmark
Dextrose	Dextrose Iran	Iran
Maltodextrin	Roquette	France
Instant starch (pre gelatinized)	Cargill	America
Carboxymethyl cellulose	Cargill	America
Caramel flavor	Aromsa	Turkey
Vanilla flavor	Givaudan	Switzerland
Hazelnut flavor	Firmenich	Switzerland
Cinnamon flavor	Firmenich	Switzerland
Cinnamon powder	Iran	Iran
Whey	Multi	Iran
Skim milk powder	Multi	Iran
powder Whole milk	Multi	Iran
creamer Non Dairy	Mokate	Poland

2-2- Treatments

Treatments and level of them are shown in Table 2.

Table 2. Addition of carboxymethyl cellulose and carrageenan in the formulation of a chocolate drink powder

Treatments	Blank	1	2	3	4	5	6
Carboxymethyl cellulose %	0	0.5	1	2	0	0	0
Carrageenan %	0	0	0	0	0.25	0.5	1

A combination that created the smallest effect in formulations were used as a filler

3-2- Method of production

Granulation method was used for instating powder mixture. Treatments were produce by Instantizer in multicafe company, model RC-R5000 / TI constructed by ICF company in Italy in 2004, under the powder feed rate 8 kg per minute, mesh size 1.5 mm, flow rate 300 kg per hour, the steam pressure 1/5 bar, dryer temperature from 125 to 135°c Contain following steps:

1- Mixing ingredients[1]

2- Grinding coarse particles in the formula to size of 100 microns[2]

3- Adding an aqueous composition (water vapor) to produce agglomerated powder[3] (water vapor was sprinkled on suspended solids in the chocolate powder after across the mesh)
4- Granules suspended in a fluid bed[4]
5- Drying to remove the aqueous composition and forming granules[5]

1- Blending
2- Grinding
3- Steam injection
4- Suspension on fluid bed
5- Removing water
At this point and in phase of the spray water composition, added sugar or sugar compounds of formula makes granules crunchy.

4-2- Physicochemical tests

To measure the moisture content, total sugar, total ash, fat and solubility of chocolate powder samples were used from the ways of the Standards and Industrial Research of Iran to arrange the numbers 383, 4714, 11138, 383 and 11137 [13, 14, 15 & 16].

5-2- Rheological tests

1-5-2- Apparent viscosity measurements

Apparent viscosity of chocolate drink was measured after mixing with hot water by Brookfield America viscometer model DV-III Ultra at 80°ᶜ. After preliminary experiments, spindle number SC4-18 was selected as most appropriate spindles and speed of 240 rpm was selected as appropriate rotational speed.

6-2- Sensory evaluation methods

For sensory evaluation was used from 20 trained panelists who were interested in participating in research, were not disease and allergies to chocolate or chocolate cravings. Taste for each panelist was performed separately but under identical conditions. The samples were placed in glass containers and used the three-letter codes to label samples. In during samples evaluation asked to panelists wash their mouths with water to eliminate the effects of previous sample taste. Finally, samples of chocolate powder after produce were evaluated the desired concentration, mouth feel, taste, smell, color, sweetness and overall acceptance, using a 5-point Hedonic (5 = much love, 4 = moderate love, 3 = neither I like nor dislike, 2 = medium dislike, 1 = dislike very much).

7-2- Statistical Analysis

Data analysis was conducted using a completely randomized design. The first factor carboxymethyl cellulose with four levels (0, 0.5, 1 & 2) and the second factor carrageenan with four levels (0, 0.25, 0.5 & 1) were added to the treatment. Comparisons were performed using Duncan's multiple range tests at 95%. Graphs were plotted using the software excel. All experiments were performed twice.

3- RESULTS AND DISCUSSION

1-3- Physicochemical characteristics

The mean values of the characteristics of moisture, total sugar, total ash, fat and solubility are shown in Table 3. About physicochemical characteristics, significant differences were not observed between samples with each other and with blank.

Table 3. Values for the physicochemical properties of chocolate drink powder containing carboxymethyl cellulose and carrageenan

Additive	Percentage	Moisture	Total Sugar	Total Ash	Fat	Solubility
	%	%	%	%	%	"
Carrageenan	0	2.8[a]	25[a]	3.93[a]	21[a]	5[a]
	0.25	2.66[a]	25.1[a]	3.96[a]	21.2[a]	5[a]
	0.5	2.6[a]	25.3[a]	4[a]	21.2[a]	5[a]
	1	2.73[a]	25.4[a]	4.12[a]	21.4[a]	5[a]
Carboxymethyl cellulose	0	2.8[a]	25[a]	3.93[a]	21[a]	5[a]
	0.5	2.82[a]	25.4[a]	4.13[a]	21.4[a]	5[a]
	1	2.7[a]	25.7[a]	4.16[a]	21.6[a]	5[a]
	2	2.87[a]	25.8[a]	4.18[a]	21.7[a]	5[a]

Similar letters in each column indicate is not significant differences at the 95% level (P<0.05)

2-3- Apparent viscosity

Apparent viscosity of chocolate drinks and similar products are important factors affecting the quality of the texture of final product. The results showed that the addition of carboxymethyl cellulose to mix chocolate drinks, apparent viscosity in values of more than 0.5 % was increased compared to control, significantly but this difference was not significant in amounts less than 0.5 %. Minimum and maximum apparent viscosity was obtained, in control subjects (0.95 mpa.s) and sample containing 2% carboxymethyl cellulose (2.6 mpa.s), respectively. Addition of carrageenan increased apparent viscosity at values higher of 0.5%, significantly, also. As the sample containing 1% carrageenan to allocate the highest apparent viscosity (1.11 mpa.s) Apparent viscosity difference between 0.25 and 0.5 % carrageenan levels were not assessed significant, But difference Between them was also significant with the 1% level ($P<0.05$).

The overall increase in the apparent viscosity of samples containing gums and thickeners is due to reaction thickener with the liquid of mixture [17] and high water absorption properties of these compounds [18]. These compounds with increasing water-binding capacity decreased flow and increased resistance to flow or the apparent viscosity [19]. In concentrations equal, carboxymethyl cellulose, further enhancing the apparent viscosity than carrageenan. Prakash et al. 2010 showed that carrageenan to increase stability and reduce the amount of sediment chocolate milk [20]. Yanes et al. 2002 showed that the use of stabilizers carrageenan, alginate and carboxymethyl cellulose increases the viscosity of the chocolate milk [21]. Schmidt and Smith, 1992 reported that concentrations of 0.05, 0.1, and 0.2% of guar gum, carrageenan and xanthan increase the viscosity flavored milk [22]. Tyjsn et al. 2007 showed that Kappa-carrageenan and Utah-carrageenan and hybrid from Utah and kappa carrageenan in concentration zero to 0.05 % led to an increase in the viscosity of milk [23] Dogan and et al. 2011 examined instant hot chocolate drink rheological behavior with optimization effect of type of starch and gum and showed that xanthan gum - potato starch composition, xanthan gum - Tapioca, xanthan gum - corn starch were the largest viscosity values and the K index [24]. Bahram Parvar et al. 1387 are known also use of carboxymethyl cellulose and Lallematia iberica M.B gum in ice cream to increase viscosity [25]. Radi and amiri 1392 generated rheological behavior of solutions containing different concentrations of carboxymethyl cellulose and concluded an increase in the viscosity of solutions containing carboxymethyl cellulose with increasing the concentration of gum [26].

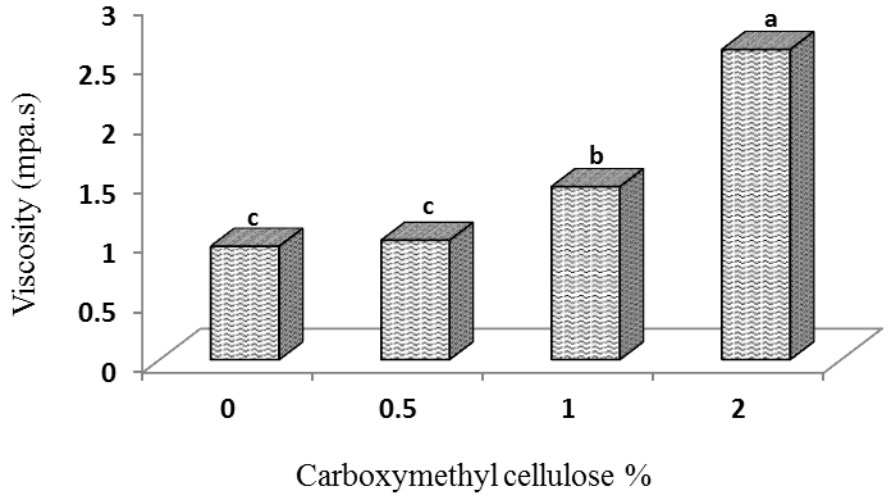

Figure1. Effect of carboxymethyl cellulose concentrations on the apparent viscosity of the chocolate drink

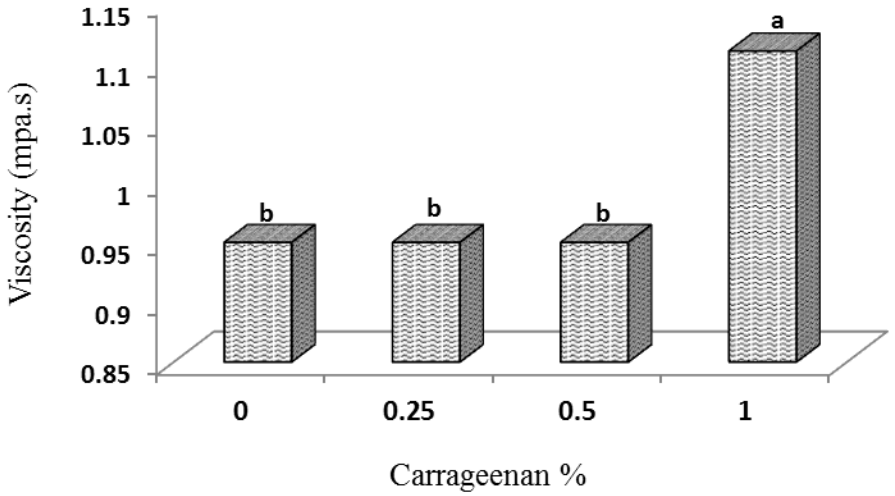

Figure2. Effects of carrageenan concentrations on the apparent viscosity of the chocolate drink

3-3- Sensory Evaluation

In compared of sensory scores samples containing carrageenan with control, reached the conclusion that Panelists were detected significant difference in odor, color and sweetness (Figure 3). Data analysis showed that with addition of carrageenan, the samples received more points compared to control. In terms of body, mouth feel and taste samples containing 0.5 and 1% carrageenan than samples containing 0.25 % carrageenan and control showed significant difference but the difference between samples containing 0.25 % carrageenan compared to the control and sample containing 1% carrageenan compared to the sample containing 0.5 % carrageenan was not significant (Figure 4). Salimian et al. 1391 recommended using a rate of 0.05 % carrageenan to produce chocolate milk with maximum viscosity, the minimum sediment amount and the most desirable sensory properties [27].

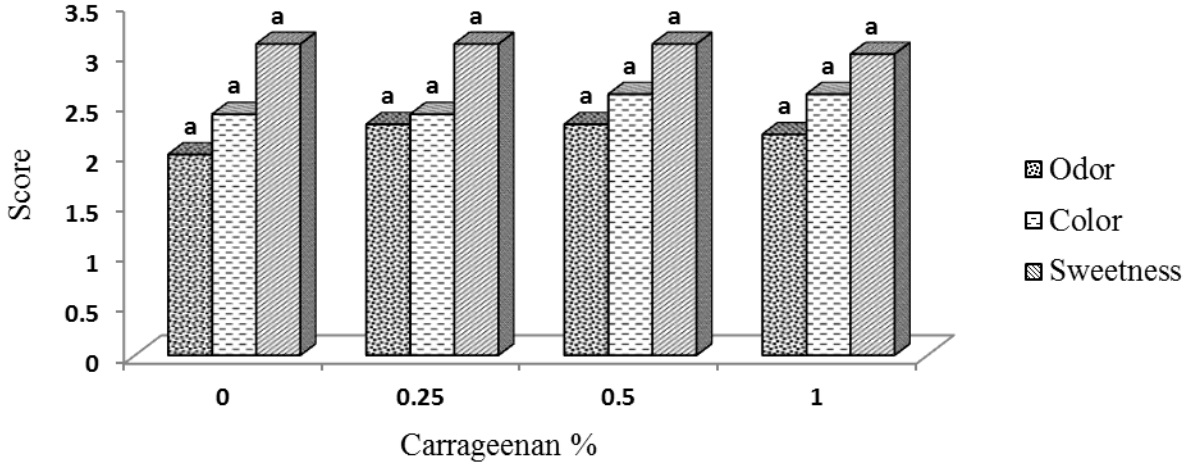

Figure3. Effect of carrageenan concentrations on some sensory properties of chocolate drink

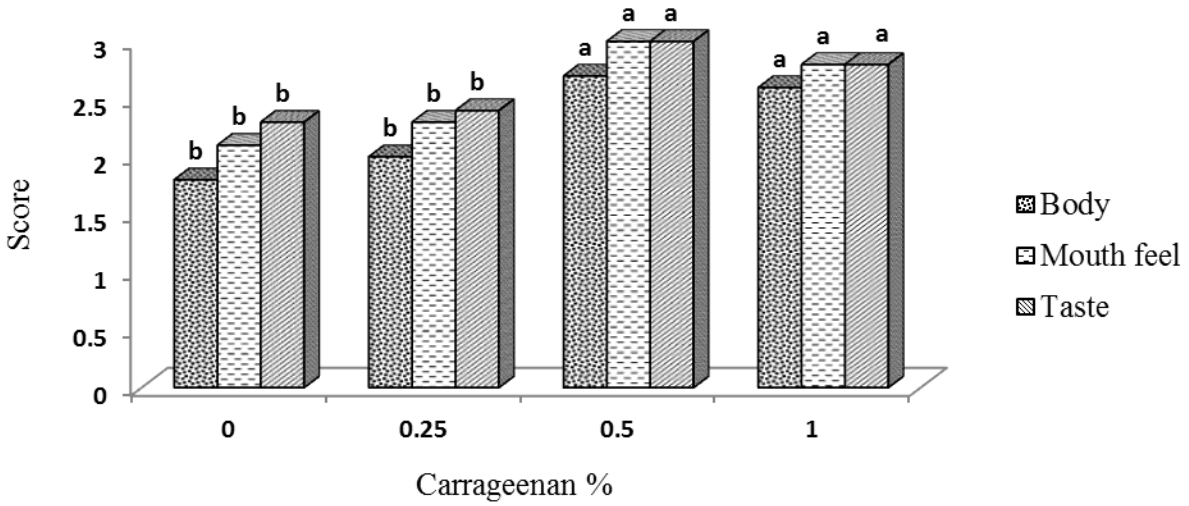

Figure4. Effect of carrageenan concentrations on some sensory properties of chocolate drink

Between different levels of carboxymethyl cellulose were not observed significant differences in terms of sweetness. With the increasing amount of carboxymethyl cellulose to 0.5, 1 and 2% compared with the control, other sensory characteristics were significantly increased but the increase in the level of 2% compared with 1% was not significant (Figure 5 and 6).

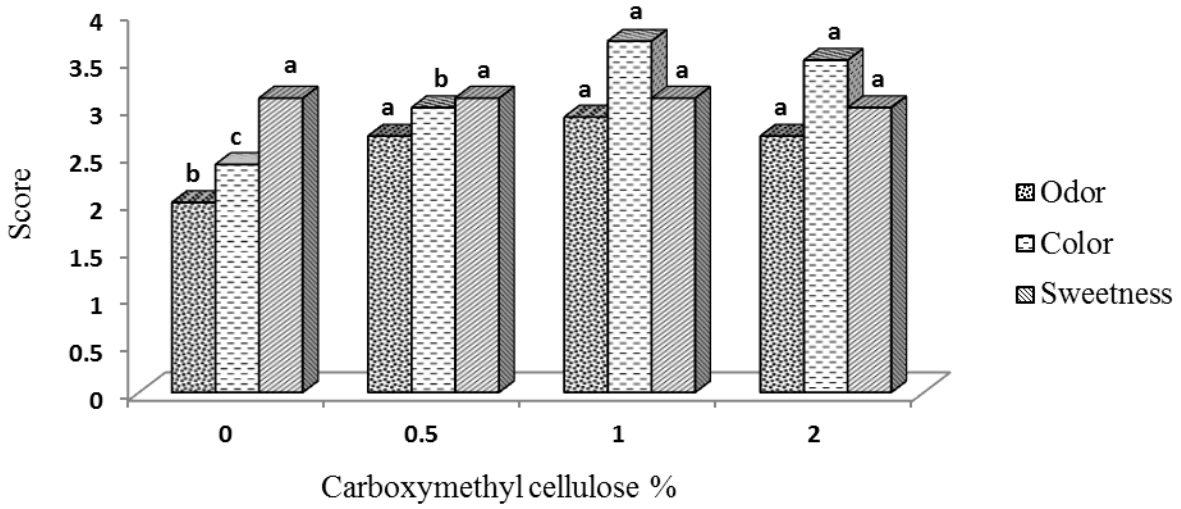

Figure5. Effect of carboxymethyl cellulose concentrations on some sensory properties of chocolate drink

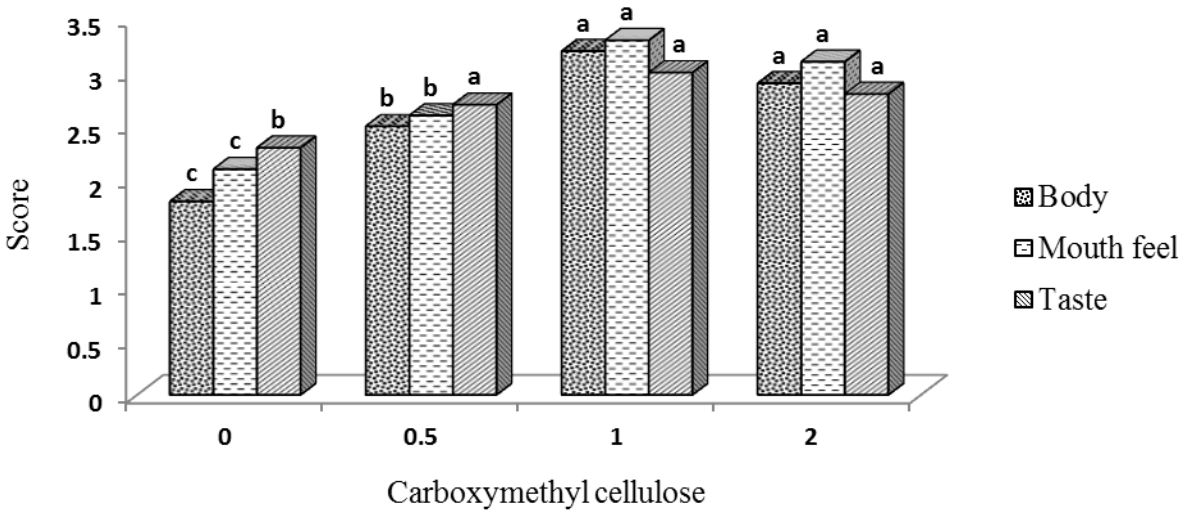

Figure6. Effect of carboxymethyl cellulose concentrations on some sensory properties of chocolate drink

And in general, in samples containing carrageenan, chocolate drink containing 0.5 % of carrageenan by Panelists was preferred the general admission. In total, Chocolate drink containing 1% carboxymethyl cellulose in terms of control, samples containing 0.5 and 2% carboxymethyl cellulose and samples containing carrageenan received higher scores by Panelists in general admission (Figure 7).

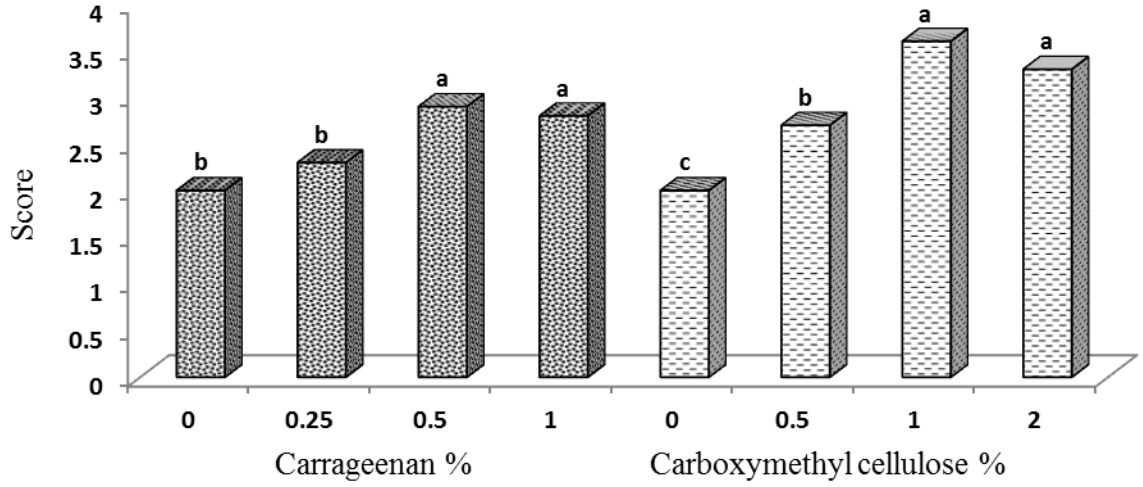

Figure7. Effect of carboxymethyl cellulose and carrageenan concentrations on general acceptance of chocolate drink

4- Conclusions

Using carboxymethyl cellulose and carrageenan in chocolate drink improve the viscosity and consistency of product but does not cause significant difference in the physicochemical properties. With increasing in percentage of stabilizer viscosity also increases so that the level of 2% carboxymethyl cellulose and 1% carrageenan showed the highest viscosity. According to the results, it was found that level of 0.5% Carrageenan and 1% carboxymethyl cellulose in terms of rheological properties and sensory are situation more acceptable than the other samples, and are introduced the best treatments.

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