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Evaluation of physicochemical and textural properties of low calorie eggplant marmalade

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ABSTRACT

In this study, the reduction of sugar content in eggplant marmalade formulation using stevia sweetener was investigated. For this purpose, two factors, the ratio of stevia to sucrose (0.001, 0.0025 and 0.0004) and the percentage of carboxy methyl cellulose (0.1, 0.2 and 0.3) on the pH, Brix, dry matter, calories, color difference, total acceptance, firmness, adhesiveness and energy of penetration were used using a factorial statistical design in three replications. The results showed a significant effect at stevia to sucrose ratio on all tests. On the other hand, the effect of CMC, although it caused changes, but only had a significant effect on the textural assays. In general, replacing sugar with stevia up to 0.0025 is desirable, and if this amount is added, some desirable properties of eggplant jam reduced. So, this new formulation of eggplant marmalade by maintaining desirable properties can play a good role in improving public health.

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1. Introduction

Diets rich in sugar along with insufficient physical activity can lead to weight gain, which ultimately causes diseases such as obesity, cardiovascular diseases, blood pressure and non-insulin-dependent diabetes. People's awareness that proper nutrition can be effective in people's health has led food producers to produce products with less sugar and more fiber that these diets can prevent the occurrence of some diseases. Nowadays, various artificial sweeteners such as cyclamate, saccharin and aspartame are used. But their use causes negative side effects on health and there are doubts about their carcinogenicity [1].

The use of stevia sweetener, which is a combination of natural origin, has been seriously welcomed in many countries. This composition is not caloric and can be a good substitute for artificial sweeteners [2]. Even though the consumption of stevia sweetener in different food and pharmaceutical industries of the world is increasing day by day, unfortunately, the use of this compound has not been developed in Iran due to little information about its importance and physicochemical properties. Sweeteners obtained from stevia show stability to heat up to 200 degrees Celsius [3]. They have stable pH, do not change color and do not ferment [1]. Stevia is a non-toxic and non-addictive sweetener. In processed form, it is 250 to 300 times sweeter than sugar [4]. It is a rich source of antioxidants, which increases the shelf life of the product due to delaying adverse chemical reactions [5]. The mechanism of its antioxidant activity has been attributed to the inhibition of free radicals and superoxides [6].

Eggplant is one of the important agricultural products that is cultivated on a large scale in different countries. According to FAO statistics in 2018, the amount of eggplant in the world is 54.07 million tons and the cultivated area is 1.86 million hectares. While in Iran, the amount of production in 2018 is 666.8 thousand tons and the cultivated area is 21.5 thousand hectares. Eggplant contains many minerals such as potassium, calcium, magnesium, copper and vitamins E, B and folic acid and is useful for patients with diabetes and gout and prevents the occurrence of blood pressure and cardiovascular diseases and lowers cholesterol. [7]. Eggplant phenolic compounds have antioxidant properties and protect the body against various bacterial and viral infections [8].

In recent years, edible jams and marmalades from various fruits such as pomegranate [9], pistachio skin [10], lime [11], kiwi [12], as well as jams made from mango [13], raisin puree [14] , strawberry [15] and watermelon [16] were prepared and their rheological, physical, chemical and sensory characteristics were measured and reported by researchers.

Research and development about marmalades made from various agricultural products has started years ago and the desire to use cheap agricultural products and waste from food factories that have good nutritional properties and significant antioxidant properties has increased. Is. Due to its low price and high nutritional value, eggplant can play a significant role in people's daily nutrition and economic and industrial growth. Because jam and marmalade play an important role in the consumption basket of Iranian households. Therefore, the production of low-calorie eggplant marmalade, which has suitable nutritional and organoleptic characteristics, can play a positive role in the nutrition and health of different people in the society.

Carboxymethyl cellulose (CMC) is a derivative of cellulose that is used in the food industry for various purposes, such as increasing viscosity, thickening, stabilizing, and increasing transparency [17]. There are several types of CMC with varying degrees of viscosity in the range of 50 cpoise (2% concentration) to 13,000 cpoise (1% concentration) in water [18]. The use of CMC as a thickener in products such as jam and marmalade has economic justification [19]. Motamedzadegan et al. (2019) studied the effect of CMC on the flow behavior and rheological properties of pomegranate paste. The results indicated that the addition of CMC led to an increase in the consistency of pomegranate paste [20]. Jana et al. (2013) also addressed the effect of CMC in fruit filling and achieved favorable results in the final product [21].

In this study, an attempt has been made to prepare low-calorie banana marmalade using stevia and pectin, which is suitable in terms of sensory and physicochemical properties. For this purpose, by

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using different formulations including different percentages of eggplant, pectin and different concentrations of sucrose, different types of marmalade were prepared and different tests such as total pectin amount, pH, ascorbic acid amount, color changes, dry matter, brix and overall acceptance. were measured.

2- Materials and methods

2-1- Sample preparation

The required amount of eggplant was obtained from the local market of Mashhad and after peeling and taking the head part, a small gap was made in the middle and 55 grams of it was placed in cold water so that the color does not darken. In order to prepare marmalade syrup, the amount of sucrose consumed (55 grams), stevia at the ratios of stevia to sucrose 0.001, 0.0025 and 0.004 and carboxymethyl cellulose (CMC) at the levels of 0.1, 0.2 and 3. 0 g was mixed in 100 ml of water. Eggplants were boiled in water. Then they were poured into a colander and immediately placed in the cooled syrup. Then mix it completely on the mixer for 1 minute, then put the container on a gentle heat so that the eggplants absorb the syrup. Then, citric acid was added to the mixture to reach its pH of 2.8 to 3.5. Then the cooling and filling stage was done in small containers and the containers were kept in the refrigerator for 24 hours in order to form a gel.

2-2- Methods

2-2-1- pH measurement

The pH of the samples was measured at laboratory temperature by a pH meter based on the national standard of Iran No. 4404 [22].

2-2-2- Brix measurement

The Brix content of the samples was measured with an optical refractometer model HSR 500 (made by Atago, Japan) [23].

2-2-3- Measurement of dry matter

To measure the dry matter, the samples were placed in a 70°C oven and weighed until a constant weight was reached. After reaching a constant weight, the samples were removed from the oven and placed in a desiccator to cool down to determine the amount of dry matter [24].

Then the percentage of insoluble solids was calculated from the following equation:

100 x (brix - total solids) = percentage of insoluble solids

2-2-4- Measuring the amount of calories

The amount of calories of the produced product was calculated from the method of analyzing the existing compounds and the amount used [25].

2-2-5- Colorimetry

The color of marmalade samples on the CIE scale (color scale) using the Hunter Lab model for measurement and standard L indicators* (black zero to white 100), a* (red 60 to green -60) and b* (yellow 60 to blue -60) have been used. First, the device was calibrated against white tiles and black tiles. Then a glass cell was placed above the light source, the samples were poured into the cell one by one and covered with a black cap, and the values of a* ، b* and L* Each sample was recorded with six replicates. ΔE The color difference of the sample with the white tile (b = 0.60).*، 24/1-=a*، 62/92= L*) which can be calculated with the following formula [26].

$$\Delta E = \left[\left(L^* - L\right)^2 + \left(a^* - a\right)^2 + \left(b^* - b\right)^2 \right]^{1/2}$$

2-2-6- Texture characteristics

To measure the texture of the histometric method using the tissue profile analysis test[1] TPA was done. For this purpose, it was done at ambient temperature and using half inch diameter cylindrical probe with a speed of 1 mm/second and a time interval of 2 seconds between two probe pressures at a distance of 4 mm and the indicators of stiffness, adhesion and force required for penetration were measured. became [27].

2-2-7- Sensory evaluation

Sensory characteristics of produced marmalades were investigated based on the 5-point hedonic method. 10 judges from among the trained people evaluated the characteristics of produced marmalades based on taste, texture and overall acceptance based on 5 highest and 1 lowest score [28].

2-3- Statistical design

In order to determine the best formulation, the comparison between 3 levels of stevia to sucrose ratio (0.001, 0.0025 and 0.004) and methyl

[1]. Texture Profile Analysis

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cellulose (0.1, 0.2 and 0.3%) from factorial statistical design in three replications used. SPSS software, version 20, was used for data analysis. The difference between the means was also compared using Duncan's multiple range test at a significance level of 0.05. Excel software was used to draw graphs.

3-Results and discussion

1-3- pH level of marmalade

Examining the results of replacing stevia with sucrose and adding carboxymethyl cellulose gum in the production of marmalade showed that the pH changed significantly due to the replacement of stevia ($P<0.05$). As shown in Table 1, replacing stevia with sucrose caused a decrease in pH. So, the lowest pH value in the ratio of stevia substitution was at the level of 0.004. Also, as expected, increasing the amount of CMC did not cause a significant change in the pH of the marmalade.

Table 1 Results of physicochemical properties of low-calorie eggplant marmalade

Treatments		pH	Brix	Dry matter	Energy (Kcal)
Stevia/sucrose	CMC (%)				
0.001	0.1	3.76±0.05^{a}	62.1±3.96^{bc}	64.6±0.14^{b}	187.76±1.64^{a}
	0.2	3.75±0.18^{a}	65.15±9.26^{ab}	65.85±1.06^{ab}	187.76±2.71^{a}
	0.3	3.76±0.22^{a}	68.75±9.12^{a}	67.25±0.63^{a}	187.76±1.2^{a}
0.0025	0.1	3.225±0.03^{b}	63.25±5.59^{b}	63.25±9.68^{cd}	174.76±1.01^{b}
	0.2	3.3±0.1^{b}	63.65±0.33^{b}	64.55±8.41^{b}	175.76±0.34^{b}
	0.3	3.3±0.07^{b}	65.3±3.25^{ab}	64.7±0.56^{b}	174.9±0.19^{b}
0.004	0.1	3.01 ±0.01^{c}	60.35±0.77^{c}	63.95±9.68^{cd}	163.76±0.18^{c}
	0.2	3.02±0.02^{c}	62.3±0.7^{bc}	63.05±9.97^{cd}	162.72±0.7^{c}
	0.3	3.03±0.01^{c}	63.65±0.91^{b}	64.35±8.98^{c}	162.76±0.01^{c}

Means ± SD (standard deviation) within a column with the same lowercase letters are not significantly different at $p<0.05$

2-3- Marmalade brix level

Examining the results obtained from replacing stevia with sucrose and adding CMC gum in the production of marmalade showed that there was a significant difference in Brix level due to the effect of stevia and the treatment of stevia with CMC gum at the level of 5%, but no significant difference was observed in the treatment of CMC gum. Replacing stevia with sucrose decreased the brix content of marmalade, and CMC gum increased it (Table 1). Thus, the lowest amount of Brix in the sample containing stevia was observed at the level of 0.004% and CMC gum at the level of 0.1%, and the highest amount of Brix was observed in the sample containing stevia at the level of 0.001% and CMC gum at the level of 0.3%. Mohammadi Moghadam et al. (2009) obtained similar results and reported that Brix level increased with the increase of all three concentration factors of pistachio skin, pectin and sugar. Also, the range obtained for Brix was similar to the results of this research [10]. In fact, the increase in the ratio of stevia to sucrose has led to a decrease in the brix content of the marmalade, which is due to the decrease in the amount of sucrose and, of course, the decrease in the amount of water-soluble solids (brix) in the product. But increasing the amount of CMC alone, since its consumption in the marmalade formulation was very low, did not have a significant effect on the Brix level of the final product. Tarabi Tabrizi and Rufe Gran (2017) also reached similar results regarding the replacement of sugar with xylitol and sucralose in cherry jam and reported that the replacement of these sweeteners had a significant effect on the Brix level of the jam and the reason for this phenomenon was the replacement of A lot of sucrose with a very small amount of sweeteners [29].

3-3- **The amount of dry matter of marmalade**

The results showed that the replacement of stevia with sucrose and the combined treatment of stevia and CMC gum caused a significant difference in the amount of dry matter ($P<0.05$). However, the use of CMC gum alone increased the amount of dry matter. But this amount did not make a significant difference at the 95%

significance level. Replacing stevia with sucrose and CMC gum increased the amount of dry matter in marmalade, so that the lowest amount of dry matter in the sample containing stevia was at the level of 0.004 and CMC gum at the level of 0.2%, and the highest amount in the sample containing stevia was at the level of 0.001 0% and CMC gum was observed at the level of 0.3%. Therefore, increasing the ratio of stevia to sucrose leads to a decrease in the amount of dry matter of the final product. This phenomenon was probably due to the lower amount of sucrose in this formulation. On the other hand, the effect of increasing the amount of CMC, although it led to an increase in the amount of dry matter, which was probably due to the addition of this substance to the marmalade formula. But due to its low consumption, it is significant at some levels. The present results are similar to the results obtained in Yildiz et al.'s (2012) research, with the difference that a higher concentration of fruit and CMC was used in the present study, and as a result, the amount of dry matter in the samples was higher [30]. Also, Mohammadi Moghadam et al. (2009) also found that increasing the amount of green pistachio skin, sucrose and pectin increased the amount of dry matter of the product. A slight difference in the amount of dry matter was related to the difference in the amount of dry matter of eggplant and pistachio green skin. Also, the amount of pistachio green skin used was slightly higher than the mentioned research, which caused an increase in the amount of dry matter [10].

3-4- **Amount**marmalade calories

Examining the results of replacing stevia with sucrose (0.001, 0.0025 and 0.004) and adding CMC gum (0.1, 0.2 and 0.3 percent)

In the production of marmalade, it showed that stevia significantly reduced the calorie content of marmalade. However, no significant difference was observed in the effect of CMC gum and the interaction effect of stevia with CMC gum ($P>0.05$). The lowest amount of calories in the ratio of stevia replacement was at the level of 0.004%. Since the amount of calories in each food item is measured according to the amount of carbohydrates, proteins and lipids, adding the amount of CMC did not affect the amount of calories in the marmalade formulation. On the other hand, the higher the ratio of stevia to sucrose, the lower the amount of calories in the final product. Tarabeh Tabrizi and Rufe Garinejad (2017) achieved similar results regarding the production of low-calorie cherry jam using sucralose and xylitol sweeteners and reported that the calorie content of cherry jam samples decreased by increasing the replacement of sugar with sucralose [29]. .

3-5- The amount of overall marmalade color changes

As can be seen in Figure 1, increasing the replacement of stevia with sucrose caused a significant decrease in the overall color changes of marmalade, and the lowest amount of overall color changes was observed in the ratio of stevia replacement at the level of 0.004. Also, the interaction effect of replacing stevia with sucrose and CMC gum reduced the overall color changes of marmalade. Thus, the highest amount of overall color changes was observed in the sample containing stevia at the level of 0.001% and CMC gum at the level of 0.1%, and the lowest amount was observed in the sample containing stevia at the level of 0.004% and CMC gum at the level of 0.3%. . Brooms and Badri (2010) during their research on sorrel marmalade by adding a concentration of 1.5 to 2.5% pectin to the formulation, reached similar results and stated that by increasing the amount of pectin, the L factor* The samples were added, which is probably due to the characteristics of gel formation and its effects on the color change factor. Probably, the increase in the amount of CMC is due to the characteristics of gel formation and also preventing the non-enzymatic browning of the product and causing the final product to be slightly lighter, but this change was not significant [31].

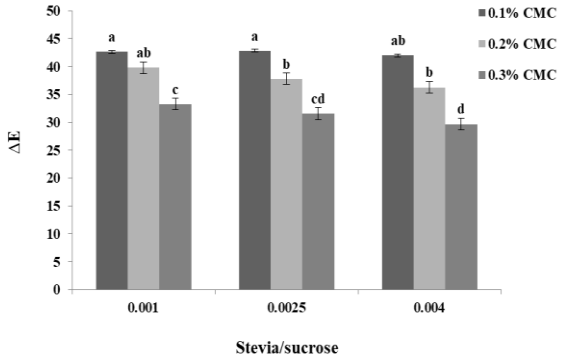

Fig 1 Effect of using stevia and CMC on color difference of low calorie eggplant marmalade The same lowercase letters are not significantly different at $p<0.05$.

6-3- The results of tissue analysis

The histological results of the treatments showed that the replacement of stevia with sucrose decreased the strength of marmalade, and with the increase of stevia replacement, the strength of marmalade decreased. So, the lowest level of Stevia replacement ratio was 0.004%. Also, the mutual effect of replacing stevia with sucrose and CMC gum on the strength of marmalade showed that the highest amount in the sample containing stevia at the level of 0.001 and CMC gum at the level of 0.3% and the lowest amount in the sample containing stevia at the level of 0.004 It was 0 percent. Gum CMC also increased significantly at the levels of 0.001 and 0.0025 stevia to sucrose. Probably, the increase in the amount of CMC due to the strengthening of the gel network has led to more strength of the tissue and has led to the formation of a stronger gel in the product. On the other hand, increasing the ratio of stevia to sucrose has led to the formation of a weaker gel network, because sucrose, in addition to increasing the sweetness of the product, has a significant effect on the textural properties and gel formation.

The results of the stickiness of the produced marmalades also showed that with the increase in the concentration of CMC gum, the stickiness increased and with the increase in the replacement of sucrose with stevia, the stickiness decreased ($P < 0.05$). So that the mutual effect of replacing stevia with sucrose and CMC gum on the stickiness of marmalade showed that the highest amount in the sample containing stevia at the level of 0.001% and CMC gum at the level of 0.3% and the lowest amount in the sample containing stevia at the level of 0.004% 0.0% and CMC gum concentration was 0.1%. The stickiness of marmalade is a function of product viscosity and consistency. Therefore, factors that increase the consistency and viscosity of marmalade also increase the stickiness of the product. Therefore, increasing the amount of stevia to sucrose (decreasing the amount of sucrose) leads to a decrease in the stickiness of the product, which is due to the role of sucrose in creating consistency and a sticky state in marmalade. On the other hand, the increase in the amount of CMC is probably due to the strengthening of the gel network and the creation of viscosity, which has led to an increase in the state of adhesion in the final product.

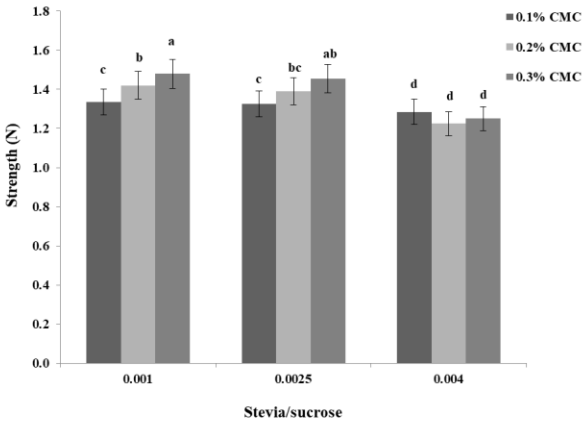

Fig 2 Effect of using stevia and CMC on strength of low calorie eggplant marmalade
The same lowercase letters are not significantly different at $p<0.05$.

The results of the amount of energy required to penetrate the marmalade showed that the replacement of stevia with sucrose significantly reduced the amount of energy in the marmalade, and with the increase in the amount of replacement of stevia, the amount of energy required to penetrate the marmalade decreased. So, the lowest level of Stevia replacement ratio was 0.004%. Also, adding CMC in some treatments increased the amount of energy required for penetration. The reason for this phenomenon is due to the resistance role of the marmalade gel network in penetration. The stronger the gel, the more energy is needed to penetrate it. Because the decrease in the amount of sucrose caused the weakening of the marmalade gel network, and as a result, the amount of energy required to penetrate the marmalade samples decreased. The effect of the combined treatment of replacing stevia with sucrose and CMC gum on the energy content of marmalade showed that the highest amount in the sample containing stevia at the level of 0.001% and CMC gum at the level of 0.3% and the lowest amount in the sample containing stevia at the level of 0.004 0% and CMC gum was observed at the level of 0.1%.

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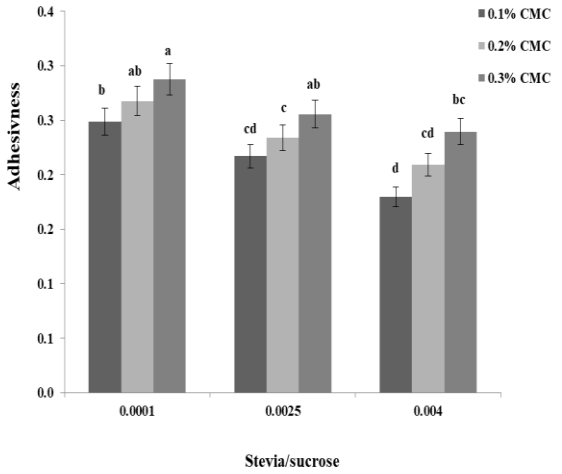

Fig 3 Effect of using stevia and CMC on adhesiveness of low calorie eggplant marmalade The same lowercase letters are not significantly different at p<0.05.

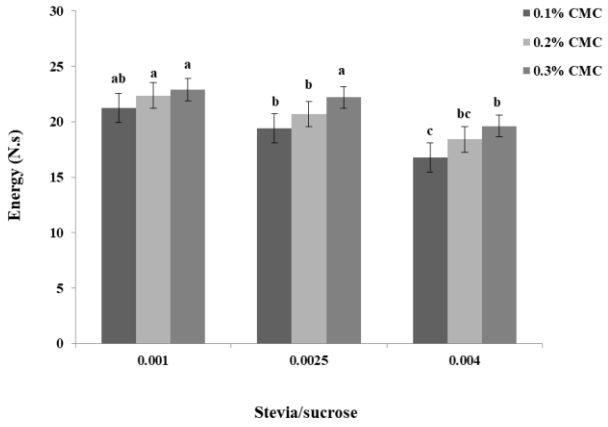

Fig 4 Effect of using stevia and CMC on energy to penetrate of low calorie eggplant marmalade The same lowercase letters are not significantly different at p<0.05.

7-3- The results of sensory evaluation of produced marmalades

The results of the sensory evaluation of treatments showed that replacing stevia with sucrose increased the overall acceptance of marmalade. Thus, the highest level of overall acceptance in the ratio of stevia substitution was at the level of 0.0025%. Also, the combined effect of replacing stevia with sucrose and CMC gum on the overall acceptance rate of marmalade showed that the highest amount in the sample containing stevia at the level of 0.0025 and CMC gum at the level of 0.3% and the lowest amount in the sample containing stevia at the level of 0.004 0.0% and CMC gum 0.1% and the sample containing stevia in 0.001% and CMC gum 0.1% was observed. Brooms and Badri (2010) stated in their research that increasing the amount of pectin had no effect on the overall acceptance of the product, which is probably due to the difference in the type of fruit used (sorrel) compared to the present study. Because the type of raw material used in the production of marmalade plays a significant role in the amount of pectin used [31]. In fact, overall acceptance is related to the taste and mouthfeel, aroma, smell and appearance of the product. Probably, increasing the amount of stevia and decreasing the amount of sucrose causes a slight aftertaste in the product, which is not desirable from the consumer's point of view, and also the decrease in the amount of sucrose has an effect on the textural properties of the product, including the strength of the gel and its sweetness, and leads to a decrease in the score. It is at the level of 0.004. On the other hand, increasing the amount of CMC does not have a significant effect on the taste of the product. But it causes textural and rheological changes in marmalade, which has led to an increase in the overall acceptance of the product. Tarabe Tabrizi and Rufe Granjad (2017) reached similar results regarding the use of xylitol and sucralose sweeteners in replacing sugar in cherry jam and reported that with the increase of sucralose, the overall acceptance of the samples decreased, which could be due to the role of sugar in Enhance the sweetness and taste (smell) of jam [29].

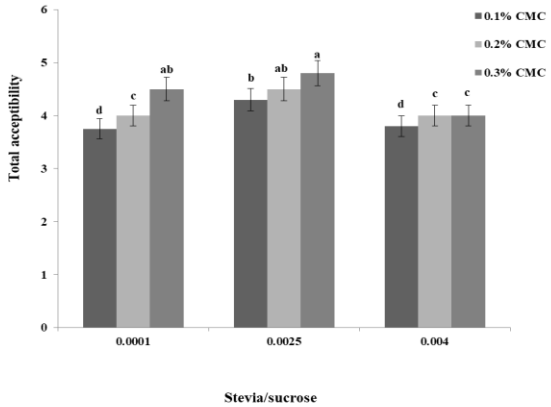

Fig 5 Effect of using stevia and CMC on total acceptability of low calorie eggplant marmalade The same lowercase letters are not significantly different at p<0.05.

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4 - Conclusion

By using eggplant and combining it with stevia and carboxymethyl cellulose, a marmalade with suitable properties can be produced, which has good physicochemical, textural and sensory properties with a reduced amount of calories. In this research, after investigating the possibility of producing marmalade using eggplant and making it bitter, and after adding different levels of stevia to sucrose and carboxymethyl cellulose in the appropriate range and adding citric acid, various tests were performed on the production product. The results indicate the success of increasing the ratio of stevia to sucrose in the low-calorie marmalade formula. By replacing stevia instead of sucrose, although some important indicators drop a little. But considering the growth of diabetes in the country at all ages and people's desire to use low-calorie products, it is possible to produce a product that is good for health by reducing the amount of sugar in the marmalade formulation. According to the results of this research, Briand Kelly suggests using a ratio of 0.0025 stevia to sugar and 0.3% CMC as a good option to replace common eggplant marmalade.

5- Resources

[1] Sutwal, R., Dhankhar, J., Kindu, P., Mehla, R. (2019). Development of low calorie jam by replacement of sugar with natural sweetener Stevia. *Internationan Journal of Current Research and Review*, 11(04), 9-16.

[2] Gao, J., Guo, X., Brennan, M.A., Mason, S.L., Zeng, X.A, Brennan, C.S. 2019. The potential of modulating the reducing sugar released (and the potential glycemic response) of muffins using a combination of a Stevia sweetener and cocoa powder. *Foods*. 8(12), 644.

[3] Goyal, S., Samsher, G.R., Goyal, R. 2020. Stevia (Stevia rebaudiana) bio-sweetener: a review.*International Journal of Food Science and Nutrition*. 61(1), 1-10.

[4] Torri, L., Frati, A., Ninfali, P., Mantegna, S., Cravotto, G., Morini, G. 2017. Comparison of reduced sugar high quality chocolates sweetened with stevioside and crude stevia ‘green’extract. *Journal of the Science of Food and Agriculture*. 97(8), 2346-2352.

[5] Savita , S. , Sheela , K. , Sunanda , S. , Shankar , A. , Ramakrishna , P. , Sakey , S. 2004 .*Journal of Human Ecology*. 15(3), 191-194.

[6] Tadhani, M., Patel, V., Subhash, R. 2007. In vitro antioxidant activities of Stevia rebaudiana leaves and callus. *Journal of Food Composition and Analysis*. 20(3-4), 323-329.

[7] Gürbüz, N., Uluişik, S., Frary, A., Frary, A., Doğanlar, S. 2018. Health benefits and bioactive compounds of eggplant. *Food Chemistry*. 268, 602-610.

[8] A review of the structure and content of phenolics in eggplant (Solanum melongena) .*South African Journal of Botany*. 111, 161-169.

[9] Dhinesh, K., Ramasamy, D. 2016. Pomegranate processing and value addition.*Journal of Food Processing and Technology*. 7(3), 1-11.

[10] Moghaddam, T.M., Razavi, S.M., Malekzadegan, F., Ardekani, A.S. 2009. Chemical composition and rheological characterization of pistachio green hull's marmalade. *Journal of Texture studies*. 40(4), 390-405.

[11] Hulburt, H.L. Dried marmalade and process of producing the same. Google Patents; 1928.

[12] Nateghi, L., Rezaei, M., Jafarian, Z., Yousefi, M. 2018. Effect of different concentrations of peach, cherry, and kiwi marmalade on some physicochemical properties of fruit yoghurt during storage. *International Journal of Biology and Biotechnology*. 15(3), 465-471.

[13] Inam, A., Hossain, M., Siddiqui, A., Easdani, M. 2012. Studies on the development of mixed fruit marmalade. *Journal of Environmental Science and Natural Resources*. 5(2), 315-322.

[14] Rababah, T.M., Al-u’datt, M., Almajwal, A., Brewer, S., Feng, H., Al-Mahasneh, M., et al. 2012. Evaluation of the nutraceutical, physiochemical and sensory properties of raisin jam. *Journal of Food Science*.77(6), C609-C613.

[15] Wicklund, T., Rosenfeld, H.J., Martinsen, B.K., Sundfør, M.W., Lea, P., Bruun, T., et al. 2005. Antioxidant capacity and colour of strawberry jam as influenced by cultivar and storage conditions. *LWT-Food Science and Technology*. 38(4), 387-391.

[16] Souad, A., Jamal, P., Olorunnisola, K. 2012.

Effective jam preparations from watermelon waste. *International Food Research Journal*. 19(4), 1545-1549.

[17] Saha, D. and Bhattacharya, S., 2010. Hydrocolloids as thickening and gelling agents in food: a critical review. *Journal of Food Science and Technology*, 47, pp.587-597.

[18] Kohajdová, Z., Karovičová, J. and Schmidt, Š., 2009. Significance of emulsifiers and hydrocolloids in bakery industry.*Slovak Chemical Acta*, 2(1), pp.46-61.

[19] Goncharuk, V.V. and Dubrovina, L.V., 2020. Rheological Properties and Water-Retaining Power of Agar Hydrogels with Carboxymethyl Cellulose. *Russian Journal of Applied Chemistry*, 93, pp.1019-1026.

[20] Motamedzadegan, A., Naeli, M.H., Maghsoudlou, E., Bahri, S.M.H., Belgheisi, S. and Babaei, Z.E.A., 2019. Effects of basal seed gum and carboxymethyl cellulose gum on rheological properties and flow behavior of pomegranate paste. *Journal of Food Measurement and Characterization*, 13, pp.87-96.

[21] Janna, C. and Svetlana, P., 2013. Influence of different hydrocolloids on physicochemical and heat-stable properties of fruit fillings. The Annals of the University Dunarea de Jos of Galati. *Fascicle VI-Food Technology*, 37(2), pp.59-67.

[22] Iran Standard and Industrial Research Institute. Standard number 4404. 1377. pH measurement in fruit and vegetable products.

[23] Iran Standard and Industrial Research Institute. Standard number 4404. 1393. Jam, marmalade, jelly and marmalade - characteristics and test method.

[24] Santanu, B., Shivhare, U. S., & Singh, T. V. 2011. Rheological, textural and spectral characteristics of sorbitol substituted mango jam. *Journal of Food Engineering*. 105, 503–512.

[25] Khouryeh, H. A., Aramouni, F. M., & Herald, T. J. 2005. Physical, Chemical and Sensory Properties of Sugar-Free Jelly. *Journal of Food Quality*. 28(2), 179-190.

[26] Tarakci, Z., 2010. Influence of kiwi marmalade on the rheology characteristics, color values and sensorial acceptability of fruit yogurt. *Kafkas University Faculty of Veterinary Medicine Journal*, 16(2), pp.173-8.

[27] Hanna, A. K., Fadi, M. A., & Thomas, J. H. 2005. Physical, Chemical and sensory properties of sugar-free jelly. *Journal of Food Quality*. 28, 179–190.

[28] Ragab, M. 1987. Characteristics of Apricot Jam Sweetened with Saccharin and Xylitol. *Food chemistry*. 6, 55-64 .

[29] Torabi Tabrizi, V., Roufegari nejad, L. 2019. Investigating the effect of sugar replacement with xylitol and sucralose as low-caloric sweeteners on the physicochemical and sensory characteristics of sour cherry jam. *Food Science and Technology*, 15(83), 227-236. [In Persian]

[30] Yildiz, O., Alpaslan, M. 2012. Properties of rose hip marmalades. *Food Technology and Biotechnology*. 50(1), 98-106.

[31] Broomes, J., Badrie, N. 2010. Effects of low-methoxyl pectin on physicochemical and sensory properties of reduced-calorie sorrel/roselle (Hibiscus sabdariffa L.) jams. *The Open Food Science Journal*. 4(1), 48-55.

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مقاله علمی_پژوهشی

ارزیابی خصوصیات فیزیکوشیمیایی و بافتی مارمالاد بادنجان کم کالری

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چکیده

در این مطالعه، کاهش میزان شکر در فرمولاسیون مارمالاد بادمجان با استفاده از شیرین کننده استویا بررسی شده است. بدین منظور دو فاکتور میزان نسبت استویا به ساکارز (۰/۰۰۱، ۰/۰۰۲۵ و ۰/۰۰۰۴) و درصد کربوکسی متیل سلولز (۰/۱، ۰/۲ و ۰/۳) بر میزان pH، بریکس، ماده خشک، کالری، تغییر رنگ کلی، پذیرش کلی، سفتی، چسبندگی و انرژی لازم برای نفوذ، با استفاده از طرح آماری فاکتوریل در سه تکرار انالیز شد. نتایج نشان دهنده تاثیر معنی‌دار نسبت استویا به ساکارز بر روی تمامی آزمون‌ها بود. از سوی دیگر، تاثیر CMC گرچه سبب تغییراتی در روند افزایش یا کاهش گردید، اما تنها در خصوص آزمون‌های بافتی تاثیر معنی‌داری داشت. به طور کلی، جایگزینی شکر با استویا تا حد ۰/۰۰۲۵ مطلوب بوده و در صورت افزوده شدن از این مقدار، برخی از خصوصیات مطلوب در مارمالاد بادمجان کاهش یافت. لذا، این فرمولاسیون جدید مارمالاد بادنجان با حفظ خصوصیات مطلوب، در بهبود سلامت جامعه می‌تواند نقش خوبی را ایفا نماید.