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The Effects of Adding Xanthan and Carboxy Methyl Cellulose on Cooking and Sensory Characteristics of Soya Burger

A. Basati [a]***, S. E. Hosseini*** [b*]

[a] *M. Sc. Student of the Department of Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.*
[b] *Associate Professor of the Department of Food Science and Technology, Science and Research Branch, Islamic Azad University, Tehran, Iran.*

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ABSTRACT: Soya burger is one of the meat replacers with low cholesterol content and saturated fats. Regarding the gums application in food systems, the effect of adding xanthan (0,0.4, 0.6%) and caboxymethyl cellulose gums (0,0.4,0.6%) on water holding capacity (WHC), cooking loss, shrinkage and sensory evaluation of soya burger have been investigated. It was found that the samples with xanthan and carboxymethyl cellulose had significantly higher ($p<0.05$) water holding capacity and shrinkage but lower cooking loss. Sensory analysis indicated that the samples with added mixtures of two gums (0.6+0.6 %) had the highest acceptability by the panelists. Consequently, this research showed that the addition of xanthan and carboxymethyl cellulose gums had successful results in physicochemical and sensory properties of soya burgers.

Keywords: *Carboxymethyl Cellulose, Sensory, Soya burger, Xanthan.*

Introduction

Modern lifestyle raises the need of less time-consuming culinary practices. Convenience food, such as burgers, are characterized by high ease of use and meet the requests of many consumers (Soriano *et al*., 2006). However, the growing demand by consumers for healthier products is stimulating the development of meat products with reduced fat content and/or altered fatty acid profiles (Ibrahim *et al*., 2011). Moreover, the consumer interest in the development of meat analogs using alternative protein sources is gaining in popularity (Gibis *et al*., 2013). According to numerous epidemiological studies, there is a link between excessive consumption of these products that often contain red meat and the risk of many disease such as cardiovascular, lung cancer, high blood pressure, kidney disorders, obesity, overweight, type 2 diabetes and metabolic syndrome (McAfee *et al*., 2010). Therefore, many non-meat ingredients have been added to a varieties of meat products to counteract the problems caused by fat reduction. These non-meat ingredients can be categorized as fat, carbohydrate or protein-based (Gibis *et al*., 2013). Soya products (soya flours, concentrates and isolates) have been used in meat systems to improve functional properties such as water binding and textural properties (Lin *et al*., 2000). Soya burgers are one of the veggie burgers that contain soya protein and other ingredients used similar to hamburgers (Bastos *et al*., 2014). Hydrocolloids were also often utilized as fat replacers in modifying both texture and

[*]Corresponding Author: ebhoseini@yahoo.com

sensory attributes of meat products. Several recent studies have examined the use of various ingredients and gums in meat products and sausage formulations (Gibis *et al*., 2013; Ibrahim *et al*., 2011; Demirci *et al*., 2014; Heywood *et al*., 2002). However, few studies have considered the effect of carboxymethyl cellulose and xanthan on meat products. Therefore, the object of this study is to evaluate the effects of adding carboxymethyl cellulose and xanthan on soya burger as an alternative meat products and also evaluate the cooking and sensory characteristics of the formulation.

Materials and Methods

- Materials

Textured soya Protein was purchased from Omraninan trade Co. (Iran), CMC and xanthan gum were from Foodyar (Iran), bread crumbs was from Narding Takestan (Iran), gluten was purchased from Ardine (Iran). Other ingredients for soya burger were purchased from local supermarket. Chemicals used in this study were of analytical grade and purchased from internal chemical suppliers.

- Preparation of soya burgers

The treatments were based on the formulation in one of the factories that were producing meat products and included textured soya (25%), flour (10%), oil (6%), salt, spices, pepper (4.48%) and water and onion (54.52%) and based on gum concentration in Table 1.

Burgers were produced according to the Iran National Standard (No. 9715) in the laboratory as follows;

1- The raw materials were weighed and then soya, water, gums, starch, flour and salt mixed together.
2- The onions were chopped by meat grinder with a grid of 10 mm.
3- The material in step 1 and 2 were mixed with flour, gluten, spices, oil and pepper by mixer for 5 minutes and then were ground by meat grinder with 3 mm mesh.
4- Finally the batter were weighted to 110 g and pressed and the Then put on wax papers and frozen at -40°C than kept at -18°C until required.

- Baking of soya burgers

Frying of samples were carried out in a frying pan with a minute amount of oil at 162°C for 3.5 minutes for one side and the other side was fried for 2 minutes therefore that the internal temperature of the samples reached 71°C (Heywood *et al*., 2002).

Table 1. Percentages of variable treatments in soya burger formulation

Treatments	CMC (%)	Xanthan (%)
Control (1)	0	0
2	0	0.4
3	0	0.6
4	0.4	0
5	0.6	0
6	0.4	0.4
7	0.4	0.6
8	0.6	0.4
9	0.6	0.6

- *Water holding capacity (WHC)*

The water holding capacity of soya burgers was carried out by centrifuge (Rotofix 32 A, Hettich), 10 grams of soya burgers were mixed with 40 ml of distilled water into the centrifuge tubes for 45 minutes and the process was carried out at 3000 rpm for 30 minutes. After removing centrifuge tubes, excess water was removed, by micropipette and the sample were weighted. The water holding capacity of the samples was calculated using the following equation (1) (Ngadi *et al*., 2011).

- *Cooking loss*

The amount of weight lost during cooking was conducted according to Akesowan et al. (2010) (Akesowan *et al*., 2011). Produced soya burgers were weighed initially and cooked by mentioned cooking method and then placed at ambient temperature until its internal temperature reached 25°C, The samples were re-weighed and the amount of weight lost was determined by the differences in weights as presented in the following equation (2).

- *Shrinkage*

The shrinkage of the samples was calculated by the standard AOAC method using an electronic digital caliper ultra plazision (Germany) as show in the following equation (3) (Ibrahim *et al*., 2011):

- *Sensory evaluation*

The features of texture, color, flavor and overall acceptability of cooked soya burger were evaluated by at least five trained panelist using 5-points hedonic scale questionnaire where score l and 5 indicated the lowest and highest scores respectiveily (Cierach *et al*., 2009).

- *Statistical analysis*

Each experiment was carried out in duplicate and measurements performed in triplicate order. Statistical analysis of the data was performed using Microsoft Excel. Analysis of variance was calculated using SPSS program with a confidence level of 0.05, to find were significant differences between the treatments.

Results and Discussion

- *Water holding capacity*

Various concentration of xanthan gum and carboxymethyl cellulose caused significant water holding capacity between all the treatments as compared to the control sample. The highest WHC was related to the treatment 9 (both gums at 0.6 %) and the lowest WHC was obtained in control sample (Table 2). Most gums have important effects on the absorption of water and viscosity in food systems (Sarteshnizi *et al*., 2015). The increase in water holding capacity in the case of soya burgers containing xanthan gums and carboxymethyl cellulose gums was due to the interactions of the gums-water or gums-protein-water and this mechanism increases the water holding capacity of the product (Foegeding *et al*., 1986). According to Table 2, the addition of a mixture of xanthan and carboxymethyl cellulose increases the water holding capacity of the burger and this reflects the fact the addition a mixture of two gum has a better effect on water holding capacity of the soya burger. Chattong et al. (2015) also reported that the addition of carboxymethyl cellulose, locust bean gum and xanthan gum

$$\text{WPC (\%)} = \frac{sample\ weight\ after\ hydration - sample\ weight\ before\ hydration}{sample\ weight\ before\ hydration} \times 100 \quad (1)$$

$$\text{Cooking loss (\%)} = \frac{raw\ sample\ weight\ - Cooded\ sample\ weight}{raw\ sample\ weight} \times 100 \quad (2)$$

$$\text{Shrinkage (\%)} = \frac{(diameter\ of\ cooked\ sample - diameter\ of\ raw\ sample) - (thickness\ of\ cooked\ sample - thickness\ of\ raw\ sample)}{diameter\ of\ raw\ sample + thickness\ of\ raw\ sample} \times 100 \quad (3)$$

Table 2. Physical characteristic of variable treatments in soya burger

Treatments	WHC	Cooking loss	Shrinkage
control	12.433 ± 0.473 [g]	11.327 ± 0.131 [a]	3.587 ± 0.019 [a]
CMC 0.4%	17.133 ± 0.416 [e]	11.110 ± 0.154 [b]	3.390 ± 1.590 [a]
CMC 0.6%	19.767 ± 0.950 [d]	10.707 ± 0.093 [c]	3.371 ± 0.058 [a]
Xanthan 0.4%	15.800 ± 0.458 [f]	11.495 ± 0.173 [a]	3.348 ± 0.026 [a]
Xanthan 0.6%	20.400± 1.277 [d]	10.232 ± 0.145 [d]	3.276 ± 0.073 [a]
0.4% CMC+ 0.4% X	24.167 ± 0.351 [c]	8.719 ± 0.026 [e]	3.194 ± 0.025 [a]
0.6% CMC+ 0.4% X	25.233 ± 0.208 [bc]	8.317 ± 0.069 [f]	3.110 ± 0.034 [a]
0.4% CMC+ 0.6% X	26.233± 0.513 [b]	7.237 ± 0.016 [g]	3.079 ± 0.031 [a]
0.6% CMC+ 0.6% X	28.967 ± 0.153 [a]	7.142 ± 0.041 [g]	2.932 ± 0.010 [a]

Values in the same column followed by different letters are significantly different ($P<0.05$)

(0.5-1%) to minced-ostrich had a significant increase in WHC as compared to the control sample. The increase in WHC by the addition of gums have been reported in previous studies (Ibrahim *et al*., 2011; Anderson *et al*., 2001; Troy *et al*., 2009).

- *Cooking loss*

Adding different concentration of gums to soya burger significantly decreased the cooking loss as compound to the control sample. Furthermore, the lowest cooking loss was found in the treatment 8 (0.6% CMC and 0.4% xanthan) while the control sample had the highest cooking loss (Table 2). Reduced cooking loss might be attributed to the increased water holding capacity which was in accordance with the results of WHC. Demirci *et al*. (2014) reported that the addition of xanthan, guar, carrageenan and locust bean gums to meatballs resulted in reduced cooking loss. This trend also observed in other studies (Luruena-Martınez *et al.*, 2004; Marchetti *et al*., 2013).

- *Shrinkage*

According to Table 2 the addition of gums did not have significant effect on shrinkage of all treatments. Shrinkage is considered as one of the important quality attributes of meat products. The results in Table 2 showed that shrinkage reduction was related to absorption and keeping moisture. Polymeric chains of soya protein contain lipophilic and hydrophilic groups. In fact, these polymer chains facilitates the interaction between protein with water and fat, thus able to keep the fat and other material in the form of protein extract to prevent and reduce shrinkage (Endres *et al*., 2001). This result was in agreement with previous studies (Ibrahim *et al*., 2011; Anderson *et al*., 2001; Ulu, 2006).

- *Sensory evaluation*

The effect of adding gum on sensory attributes of soya burgers is presented in Table 3. In this study no flavorings were used in the treatments and only mixed seasonings were employed in the control sample. According to Table 3, the panelists gave the highest scores to treatments 8. This might could be due to the application of carboxymethyl cellulose gum. In addition, added gums increased the water absorption in the samples 2 and 8, thus increased the juiciness and thereby improved the taste characteristics of the product. The addition of xanthan gum reduces the taste of soya burgers as compared to the control sample, due to the bitter after-taste that was felt by the panelists. Increasing xanthan gum in treatments 5 and 8 reduced the taste scores while mixture of xanthan and CMC caused undesirable flavor that was created by xanthan. Rather *et al*. (2015) also found the same report that the addition of xanthan gum to meatballs reduced the taste scores as compared to the control sample. In respect of flavor there were not significant

Table 3. Sensory evaluation of variable treatments in soy burger

Treatments	Taste	Flavor and odor	Texture	Color	Overall acceptability
control	4.000 ± 1.000 [ab]	3.667±0.577[a]	1.000±0.000[g]	2.337±0.557[e]	1.000±0.000[c]
CMC 0.4%	4.667± 0.557 [a]	4.000±1.000[a]	2.000±0.000[f]	3.000±1.000[cde]	2.000±0.000[bc]
CMC 0.6%	4.667 ± 0.557 [a]	4.000±1.000[a]	2.667±0.557[ef]	4.000±0.000[abc]	2.667±1.528[abc]
Xanthan 0.4%	2.667 ± 0.557 [c]	3.000±1.000[a]	3.000±1.000[de]	2.667±0.557[de]	2.000±1.000[bc]
Xanthan 0.6%	1.333 ± 0.557 [d]	2.667±0.557[a]	3.333±0.557[cde]	3.000±1.000[cde]	2.667 ±0.557[abc]
0.4% CMC+ 0.4% X	3.333 ± 0.557 [bc]	3. 333±1.155[a]	3.667±1.155[cd]	4.333±0.557[ab]	3.000±1.000[ab]
0.6% CMC+ 0.4% X	3.333 ± 0.557 [bc]	3.667±0.557[a]	4.000±0.557[bc]	3.667±0.557[abcd]	3.667±1.528 [ab]
0.4% CMC+ 0.6% X	2.667 ± 0.557 [c]	3.000±1.000[a]	4.667±0.557[ab]	3.333±0.557[bcde]	4.000±1.000[a]
0.6% CMC+ 0.6% X	4.667 ± 0.557[a]	4.000±1.000[a]	5.000±0.557[a]	4.667±0.557[a]	4.333 ±0.557 [a]

Values in the same column followed by different letters are significantly different ($P<0.05$)

differences between all the treatments. The panelists scored treatment 8 as the best texture. In general, treatments had higher texture scores than the control sample. Haghshenas *et al*. (2014) also reported higher scores for texture by adding 1% CMC to shrimp nugget (Haghshenas *et al*., 2014). The addition of gums resulted higher color scores than the control sample, therefore, treatment 9 had the highest score regarding color. Ang (1993) reported that nuggets containing cellulose has lighter color than the control sample. Unlike other carbohydrates, cellulose (complex carbohydrates) is not subjected to non-enzymatic browning. Regarding overall acceptance, treatment 9 scored higher than other treatments. This showed that the addition of xanthan gum and carboxymethyl cellulose alone had little effect on overall acceptability.

Conclusion

The addition of xanthan and carboxymethy cellulose to soya burger formulation significantly ($P<0.05$) reduced shrinkage and cooking loss while lead to increased water holding capacity. The addition of mixture of these two gums (0.6+0.6 %) had successful results in shrinkage, cooking loss and water holding capacity of soya burgers. Sensory test indicated that there were not negative effects in the formulated soya burger regarding the organoleptic attributes therefore, these gums might successfully be used in soya burger formulation.

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