Water Mobility in Gluten-Free Red MeatSausage Containing Pea and Corn Flour and HPMC Gum

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Abstract

Gastrointestinal diseases are of great importance among human societies, especially in developing countries. One of these diseases is celiac disease. Celiac is a disease of small bowel that is created due to gluten consumption. In Iran, Celiac disease has high prevalence in the general population, especially in high-risk groups, such as patients with irritable bowel syndrome or type 1 diabetes. Celiac treatment is the exit of gluten from the food. Having chronic illness and a heavy diet in lifetime can cause a lot of damage in various areas of physical and mental health and quality of life. Today, in many countries, extensive studies are conducted in different fields related to this disease. Due to the lack of gluten-free meat products in Iran, this study aims to study and investigate thermal gravimeteric analysis (TGA) sausage of 55% red meat of gluten-free containing corn and pea flour with different percentages (8:2, 6:4, 4:6, 2:8) and 0.3% HPMC gum. The results were analyzed using SPSS software and Duncan test. Based on the results,the highest amount of protein (15.6%), was related to treatment 4 (8% pea flour + 2% corn flour + 0.3% HPMC gum) ($P<0.05$). In TGA, treatment control had the highest free water and treatment 4 (2% corn flour + 8% pea flour + 0.3% HPMC gum) had the highest first and second bonded water ($P<0.05$). Finally, treatment 4 (8% pea flour + 2% corn flour + 0.3% HPMC gum) was selected as the best formulation for increasing protein and free water reduction.

Keywords:*Corn, Gluten-free sausages, HPMC gum, Pea,Thermal gravimeteric analysis*

Introduction

Among foods, proteins are known as the basic factors of life which their recommended levels in healthy people are 70.8 g per kg body weight and supplies 10% of total calories for nitrogen balance (zare*et al*., 2006). Sausages are one of the oldest forms of meat products that were first developed by the sumerians about 300 years B.C. (Foroughi *et al*., 2012). But unfortunately, some people in the society are not able to use this product due to specific diseases. One of these particular diseases is celiac disease (Arendt *et al*., 2008). Celiac disease is an intestinal disorder that is caused by eating gluten in sensitive individuals. Gluten in celiac patients causes inflammation and swelling of the small intestine that causes incomplete absorption of essential nutrients such as iron, calcium and fat-soluble vitamins, and sometimes leads to weight loss, diarrhea, anemia, fatigue, abdominal distension and folate deficiency

(Blades, 1997; Murray, 1999). The wheat, barley and rye should be removed from a gluten-free diet and grains like corn and rice be used in gluten-free diet (Haboubi *et al*., 2006). On the other hand, one of the most important factors in preserving food is the use of temperature and removal of water to prevent the growth of microbes and the activity of enzymes (zare *et al*., 2006). In the present study, possibility of producing a new product with higher nutritional value and acceptable quality is evaluated through replacing pea and corn seed flour and use of HPMC gum in the formulation of gluten-free sausage. Samples of prepared sausage were tested for thermal gravimeteric analysis (Free and bonded water).

Materials and methods

Frozen meat from brazil country, pea flour from kesht sabz company, tooth horse corn flour from tarkhineh company, HPMC gum from adonis gol darou company, nitrite sodium from BASF.SE germany, polyphosphate sodium from basam company of Iran , ascorbic acid from china HL.Vitamin company. Soybean oil, salt, spices and sugar were purchased from local stores.

To prepare the samples the test and error method, were used from the combination of (2, 4, 6, and 8%) ratios of corn and pea flour with 0.3% HPMC gum and the mentioned levels were produced along with the control sample. Frozen meat was minced in two stages with a meat grinder below zero with 25 mm diameter and then minced with a meat grinder above zero with 5 mm diameter. Firstly, the minced meat entered into the cutter (Single Test Cutter RPM1000) and the process of crushing was carried out, then nitrite, 1.3 ice, spices, edible salt, polyphosphate sodium were added and the Catherization process continued for two to three minutes. Next, the oil and the rest of the ice were added. After several rounds of Catherization, filler materials (Corn and pea flour) and other additives (Sugar, ascorbic acid and spices) were added. This process was completed 4 to 5 minutes to make a complete emulsion paste with temperatures of 4 to 5 ° C and finally, HPMC gum was added. Then the prepared dough was refrigerated above zero for one hour. In order for the filling process to be carried out better filler from Germany called filler VF628 and polyamide caliber 28 cover were used and the product was transferred to the baking room for the thermal process. Baking was carried out at temperature 85 ° C for 45 minutes. Afterwards, the temperature of the sausage was lowered to 25 ° C using shower of cold water and they were then transferred to the 2 to 4 Celsius degrees refrigerator for the experiments. The protein content was measured using the microcoldal method (AOAC, 2000).

The 10 mg sample was placed in small stainless steel containers and temperature was elevated from 25 ° C to 180 ° C under nitrogen gas at a temperature difference of 10 ° C to test thermal gravimeteric analysis (TGA) (Fitzgerald, 2005).

The resulting data from three replications of this study were analyzed in a randomized completely design with factorial arrangement by SPSS 18 software. Duncan test was used to compare the mean of data.

Results

According to Table 2, the protein content of all treatments was with significantly difference higher than control ($P<0.05$). The lowest protein content of sausages was related to the control sample and the highest level was related to treatment 4 (8% pea flour + 2% corn flour + 0.3% HPMC gum).

Table 1. Protein content of wheat, tooth horse corn, pea flour

Treatment	Protein (%)
Pea flour	17.91^{a}
corn flour	10.22^{b}
Wheat flour	8.1^{c}

The same letters are no significant difference($p>0.05$).

Table 2. Protein content in the sausage samples containing HPMC gum and different percentages of tooth horse corn and pea flour

Treatment	Protein (%)
control	14.40^{e}
1 (8% corn flour + 2% pea flour + 0.3% HPMC gum)	15.01^{d}
2 (6% corn flour + 4% pea flour + 0.3% HPMC gum)	15.22^{c}
3 (4% corn flour + 6% pea flour + 0.3% HPMC gum)	15.45^{b}
4 (2% corn flour + 8% pea flour + 0.3% HPMC gum)	15.60^{a}

The same letters are no significant difference($p>0.05$).

The observed results shown in Tables 3, treatment 4 had the lowest free water (86.10), the most first bonded water (88.17) and the most second bonded water (87.55), the control treatment had the highest free water (89.12) and the lowest first bonded water (84.37) and the lowest second bonded water (79.29) ($P<0.05$).

Table 3. Comparison of average of changes of free water (ΔW1) and bonded water (ΔW2, ΔW3) in the sausage samples containing HPMC gum and different percentages of tooth horse corn and pea flour

Treatment	ΔW1 (mg)	ΔW2 (mg)	ΔW3 (mg)
control	89.12[a]	84.38[b]	79.29[e]
1(8% corn flour + 2% pea flour + 0.3% HPMC gum)	88.55[ab]	87.48[a]	83.82[d]
2(6% corn flour + 4% pea flour + 0.3% HPMC gum)	88.19[bc]	87.30[a]	85.95[b]
3(4% corn flour + 6% pea flour + 0.3% HPMC gum)	87.49[c]	87.41[a]	84.98[c]
4(2% corn flour + 8% pea flour + 0.3% HPMC gum)	86.10[d]	88.17[a]	87.55[a]

The same letters are no significant difference($p > 0.05$).

Discussion

Agriculture products such as chickpea, lentils, beans and peas are the most important sources of protein, starch and dietary fiber in foods. Agricultural products contain 17.5 to 30 percent protein, 35 to 52 percent starch 14.6 to 23 percent of the dietary fiber in their dry matter (Mohammed *et al* ., 2012). Protein content of different varieties of corn based on dry weight is 12-6%. About 75% of protein is in the endosperm tissue and the remaining protein is distributed between bud and shell (Shukla and Cheryan, 2001). In wheat grain, there is also 7 to 18 percent protein (depending on the type of wheat) (gharouni, 2003). Based on the results of Table 1, the protein content of corn and pea flour is significantly higher than wheat flour, high levels of replacement has its own effect and therefore the protein content of these samples are higher (P<0/05). Hallen *et al*. (2004) observed protein increase in the bread by adding Bean sprout flour to wheat flour.

It seems that the amount of bonded water has increased due to the high protein content in sample 4 and the use of HPMC gum. This is consistent with the results of Verbeken *et al*. (2003) which tested the effect of xanthan and tragacanth gum on the negative effects of ice crystals investigated in frozen foods. They observed that these gums absorbed more water due to their hydrophilic structure and fixed the freezing water (Free water) and reduced and controlled the negative effects of ice crystals (Verbeken *et al*., 2003). The HPMC gum immediately after putting up in water, absorbed the water and produced a sticky and tasteless liquid that had high intrinsic viscosity (Miller and Hoseney, 1993). In addition to gums, proteins are also a group of materials which due to their high tendency to absorb water could as play a role in the stability of the dough stabilizers. The viscosity of the product increases at high concentrations of protein and gum, so that they form thick layer through bonding the water and prevent the movement of the water (Singthong *et al*., 2009).

Conclusion

Through the analysis of results this study can conclude that replacement of pea flour and corn in the formulation of sausage can help increase the protein content of this product.The HPMC gum increased the water content of the product due to presence of hydroxyl groups and insolubility at high temperature creating a strong gel network which stabilized and bonded free water. In this study, the best replacement for the percentage of pea and corn seed flour in sausage of free glutens was found to be , 8% corn, 2% pea and 0.3% HPMC gum instead wheat flour.

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