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Research Article

# EFFECT OF MICROBIAL TRANSGLUTAMINASE ENZYME ON RHEOLOGICAL AND ORGANOLEPTIC CHARACTERISTICS OF MEAT NUGGET PRODUCTS

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**Abstract**

The aim of this study was to investigate the effect of microbial transglutaminase enzyme on rheological and organoleptic characteristics of meat nugget products. Nuggets produced with different percentages including 100% red meat, 100% chicken and equal mixing of both meats (50/50) and various enzyme densities (0, 0.75, 1.5%) and characteristics such as The permeated water, oil uptake, hardness, cohesiveness, elasticity, adhesion and chewiness, taste and smell, were studied in this research. Enzyme density of 75% had the most preventive effect of less permeated water in fried nuggets. The enzyme-free sample absorbed less and in next rank the 75%-enzyme density was placed. Red meat 50% nugget and chicken 50% nugget, both enzyme-free, absorbed less oil. There was no significant effect of enzyme and meat rates on cohesiveness, elasticity, adhesion and chewiness. Samples with 75% enzyme had a better taste compared to samples with 1.5% enzyme. There wasn’t any significant effect of enzyme on the smell of the products. Samples with 75% enzyme had a higher average total acceptance.

**Keywords:** Transglutaminase, nugget, rheological, organoleptic

## 1. Introduction

There is nowadays an increasing demand for prepared foods of which one of the most important are paste products. These products are covered with a coating and then undergo the preliminary heating process. The coating protects the humidity of the product and prevents from its quality loss. As a result, a product tender and juicy with a crisp appearance is produced. (Chen *et al*., 2009; AddJit *et al*., 2009). Coating is also helpful for reduction of oil absorption (Pintus *et al*., 1995; Kasama & Nagadi, 2004). On the other hand, most customers demand for healthier and less salty foods. Reduction of salts without quality loss is possible by adding Dairy proteins and enzyme transglutaminase (Yursti *et al*., 2004; Kardoso *et al*., 2010).

Characteristics of Proteins such as gel suppliers, water holding capacity, viscosity, thermal stability, emulsifying properties and foaming show the relationship between structure and components of the protein (Ioneska *et al*., 2008). In order to improve the practical protein features of foods we use physic-chemical and enzyme methods (Gerard, 2002; Eyoneska *et al*., 2008). However, enzyme method is more considerable in controlling the desirable performance (Stanjireski *et al*., 2008) of proteins in certain time (Ahmad *et al*., 2009). In recent years, it is proved that transglutaminase enzyme is able to improve the protein properties in different cases and we can use it in order to modify the proteins' practical properties in food industries (Motoki and Segoro, 1998).

Using this enzyme leads to reduction in salt usage without any negative effect on prepared foods. This enzyme can be active in lower temperatures than denaturation of protein. Myofibril proteins are responsible for heat accumulation such as gelation and bounding without changing their nature. The aim of this study is to decrease the salt usage and improvement of rheological and texture properties of nugget using transglutaminase enzyme and temperature and time treatments, plus determining the optimum conditions of transglutaminase enzyme in different temperatures and different salt-enzyme densities.

## 2. Material and methods

### 2.1. Nugget preparation

Nugget was produced using chicken and red meat (according to the treatments), flour, oil and toasted flour (each of which 2%), spices and starch (each of which 1%), egg (3%), microbial transglutaminase enzyme (according to the treatments) based on national License number 9868 approved by the Ministry of Health, Treatment and Medical Education of Iran. Chicken breast meat and cattle meat with desirable quality were bought from supermarkets in the city. Toasted flour, starch, spices (Golha, Iran), egg (Talavang, Iran), flour (Jam, Iran), oil (Ghonche, Iran) were also bought from supermarkets.

Meat and chicken were grinded using a Moulinex (France) grinding machine (pore diameter of 2 mm) after fat being removed. Adding the additives based on table 1, we prepared a homogenous paste with an electric mixer. Finally, activated MTG (microbial transglutaminase enzyme) (1% enzyme, 99% maltodexterin, with activation 100 unit/g) was added to the paste and kept in 4 centigrade degrees for 6 hours.

Nine treatments were prepared:

Treatment 1: 50% red meat+50% chicken

Treatment 2: 50% red meat + 50% chicken + MTG enzyme 0.75 w/w

Treatment 3: 50% red meat + 50% chicken + MTG enzyme 1.5% w/w

Treatment 4: 100% red meat

Treatment 5: 100% red meat+ MTG enzyme 0.75% w/w

Treatment 6: 100% red meat + MTG enzyme 1.5% w/w

Treatment 7: 100% chicken

Treatment 8: 100% chicken + MTG enzyme 0.75% w/w

Treatment 9: 100% chicken + MTG enzyme 1.5% w/w

Then, nuggets were formed using prepared cases, 3 cm in diameter and 1.5 centimeters in thickness. These cases were covered in corn starch coatings and after being dipped into eggs for 5 seconds, and finally, were rolled in toasted flour (Tordak, Iran). At next level, in order to primarily cooking, nuggets were fried in grills in 180±5 centigrade degrees for 30 seconds. Samples were frozen using zipped lock packets in -20 $^{o}$C for one week. After one week, samples were fried in grill without defrosting process, in 180±5$^{o}$C for 3 minutes. Samples then were cooled and packed in plastic covers and transferred to the refrigerator (4 $^{o}$C) and kept for other tests.

**2.2. Permeated water:**

Weighted nugget samples was placed between two Wattman papers. A 5-kilogram weight was placed on it for 2 minutes. They were weighted again and the permeated water was measured using the following formula: (Radmehr, 2013).

$$\textit{Permeated water} = (\textit{secondary weight} - \textit{primary weight}) / \textit{primary weight} \times 100$$

**2.3. Oil absorption rate**

Fat was measured based on Standard method of AOAC (AOAC, 1990). Products' fat before and after grilling was extracted using n-Hexan Suckcele device. After evaporation of the solvent, Suckcele balloon weight was measured and the amount of oil was calculated by decreasing this weight from the empty balloon weight. The extracted fat weight difference before frying the weight of extracted fat dairy products after frying is equal to the amount of oil absorbed.

**2.4. Texture test (Texture chart analysis)**

In this test, adversity rate, cohesion, elasticity rate, and chewiness of the nuggets were calculated using Texture Analyser with a cylindrical probe of 50 mm diameter during a 2-level test. The sample was compressed to 50% of the primary height with pushing speed of 1 mm/min with a force of 0.1 N.

**2.5. Organoleptic analysis**

Referees tested the texture, taste, smell and general acceptance of the final product.

At least 10 people were trained as referees in a few briefing sessions. Scoring was based on a five point hedonic method with coded questionnaires by test panel referees (Chen *et al.*, 2009).

**2.6. Statistical analysis**

Nine treatments were investigated in this study with 3 repetitions. Analysis was performed using SPSS and One-way Anova method. Excel software was used for drawing the charts and figures.

**3. Conclusion and discussion**

The effect of microbial transglutaminase enzyme on rheological and organoleptic characteristics of meat nugget products are explained as follows.

**Fried nugget permeated water**

Comparison of the average effect of different meat combinations on permeated water of fried nugget shows no significant relationship. Different densities of MGTASE enzyme had effects on permeated water of fried nuggets (fig. 1). A3 density (3.59) caused the most permeated water and A2 (3.12) caused the least permeated water.

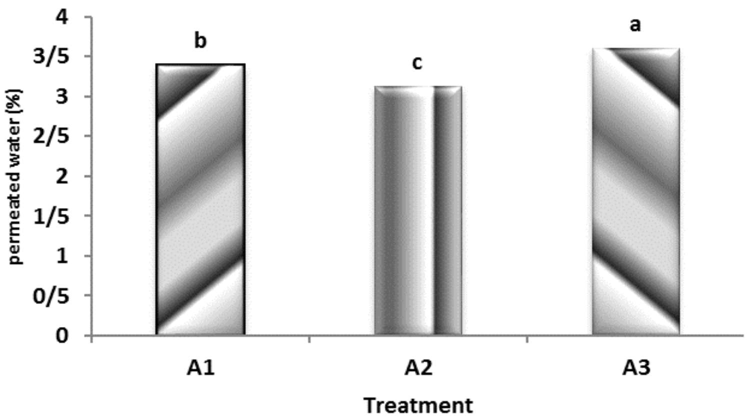


**Fig 1. The effect of enzyme densities on permeated water in fried nugget: enzyme-free (A1), 75% enzyme (A2), 1.5% enzyme (A3).**

Comparisons between interactive effect of meat different combinations with enzyme different enzymes on permeated water of fried nuggets show that M1A2 (4.46) red meat and chicken with 75% enzyme , M3A3 chicken with 1.5% enzyme (4.25) had the most permeated water, and M1A3 (2.04) red meat and chicken combination with 1.5% enzyme had the least permeated water amount. It is likely that microbial transglutaminase enzyme have the potential to change protein dense gel into gels. Gelatinization of muscle proteins is responsible for physical and chemical permanence of fat and water in meat products. As a result, this phenomenon can reduce the permeated water by building a desirable texture (Castro-Briones *et al*., 2009).

Results of Radmehr study (2011) on chicken nugget with different amounts of enzyme from 0 to 1.5% and different doses of salt from 0 to 1.5% and time treatment of 0 to 45 minutes in 40 $^{o}$C showed that salt and enzyme are both reductive of permeated water rate.

Existence of microbial transglutaminase enzyme can reduce the cooking-waste rate and increase the chewiness and adversity of the product. However, microbial transglutaminase enzyme in salt-free treatments cannot improve these parameters in conditions of high salt density (Pitrasik and Lichan, 2002).

**Fried nugget fat**

Comparison between the effects of different mixes of meat on fried nugget fat absorption (fig. 3) suggests a significant effect. M2 mix (11.353) has the fattest absorption and M3 mix (6.412) has the least fat absorption.

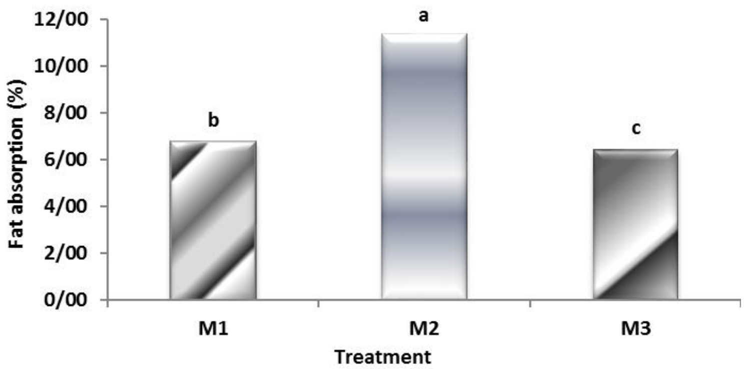


**Fig 2. The effect of different meat densities on fat absorption of fried nugget: mixed nugget (M1), red meat nugget (M2), chicken nugget (M3).**

Comparison between MGTASE enzyme densities (fig. 4) shows that A3 density (9.027) causes the most fat absorption and A1 (6.955) causes the least fat absorption.

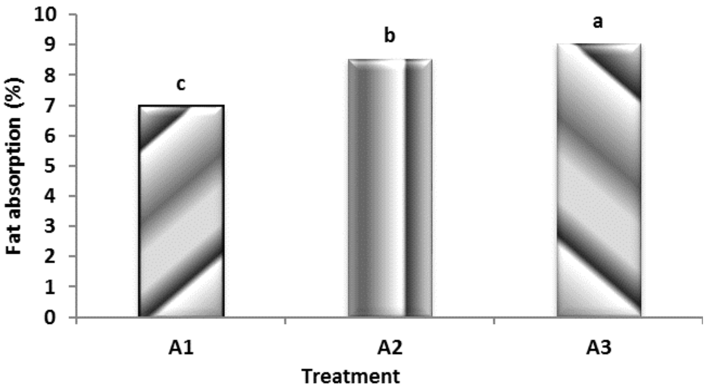


**Fig 3. effect of enzyme densities on fat absorption of fried nugget:**

**Enzyme-free (A1), 75% enzyme (A2), 1.5% enzyme (A3).**

Comparison between the interaction of different combinations of meat and different concentrations of enzyme on fat absorption of fried nugget shows that M2A2 (12.705) red meat nugget and 75% enzyme have the most fat absorption and M1A1 (5.210) combination of meat and chicken without enzyme have the least fat absorption.

In a study by Radmehr (2011) on chicken nugget in different enzyme densities (from 0 to 1.5%) there was no significant linear effect of enzyme activity on fat absorption.

**Rheological properties**

**Adversity:** Mean comparisons of different combinations of meat on adversity (fig. 4) shows that M1 combination (2286.11) has the highest adversity and M3 (1408.556) has the lowest adversity.

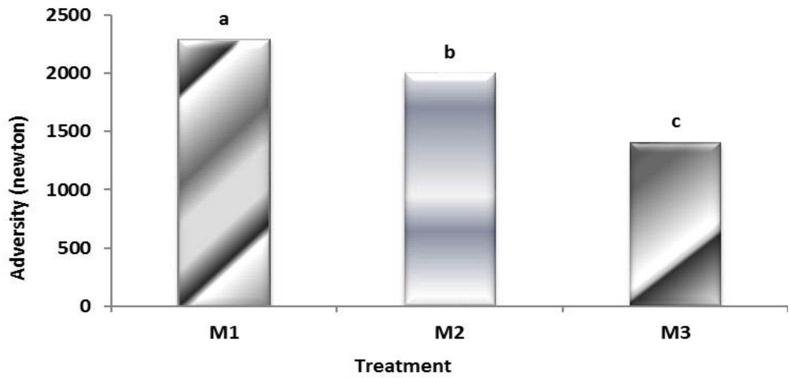


**Fig 4. the effect of different meat combinations on nugget adversity:**

**Mixed nugget (M1), red meat nugget (M2), chicken nugget (M3).**

Comparison between MGTASE densities (fig. 5) shows that A2 density (2070.889) causes the highest adversity and A1 density (1767.222) causes the lowest adversity.

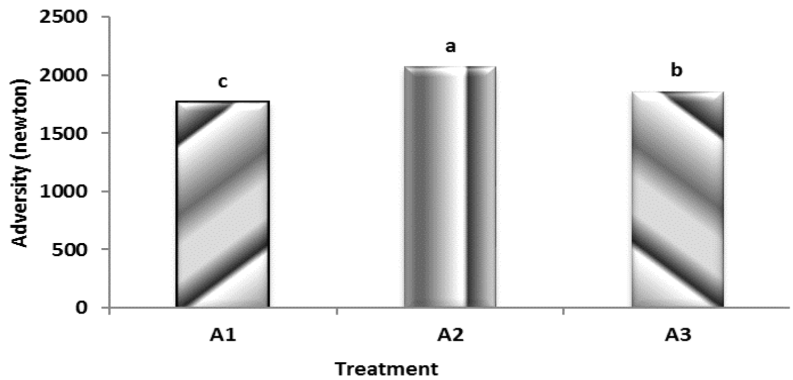


**Fig. 5. the effect of different enzyme densities on nugget adversity:**

**Enzyme-free (A1), 75% enzyme (A2), 1.5% enzyme (A3).**

Comparison of interactive effect of different meat combinations and enzyme densities on adversity shows that M1A3 (2348) nugget with chicken and red meat and 1.5% enzyme has the highest and M3A1 (919.33) chicken nugget without enzyme causes the lowest adversity.

**Cohesion, elasticity, adhesion and chewiness**

There wasn't any significant effect of meat and MGTASE densities on cohesion, elasticity, adhesion and chewiness properties. Also there wasn't any significant effect of meat and density interaction.

A study on tilapia fish steak showed that microbial Transglutaminase enzyme improves the quality loss of cooking and gives the products properties such as chewiness and oral sensibility (Lusia *et al*., 2014).

Adding active Transglutaminase enzyme in Fitofack and Kapoor fish leads to an increase in elasticity at the end of 30 degrees. In Trout fish, between 20-25 centigrade degrees, G' is higher than sample with non-active enzyme. It is probably because microbial Transglutaminase enzyme helps creating Molecular cross inside and outside links that need a lower temperature for building an elastic structure. In chicken meat, there is no considerable difference between active-enzyme and non-active enzyme samples of which reason may be the structure of chicken meat protein (Radmehr, 2012).

**Organoleptic properties**

**Taste**

Studies on the effect of meat combination on taste show a significant relationship. M1 combination (4.833) has a better taste and M3M2 combinations are in lower ranks after M1. Comparison of average effect of MGTASE enzyme densities show that A1 density (5) has a better taste and A3 (4.033) has the worst taste. M1A1, M1A2, M1A3 and M2A1 combinations of density and meat are respectively the 5 best tastes.

**Smell**

Analysis of variance of the effect of different combinations of meat and MGTASE enzyme densities on smell of the products do not show any significant relationship between them. There is also no significant relationship between meat and density. In a study by Gonkalo and Pasos (2010) microbial transglutaminase enzyme was used in three weight rates of 0.5, 1 and 1.5% in Fish tailor-made product. Results showed that weight rate of 1.5% has higher performance compared to other ones, regarding properties such as texture, smell, taste and appearance of the product.

In a study by Tsung *et al*., (2006) they reported that adding different amounts of transglutaminase doesn't change organoleptic properties of meat.

**General acceptance of product**

There was no relationship between the effect of meat and density on general acceptance of the product. Comparisons show that M1 and M3 had the highest rate of general acceptance and M2 had the lowest one.

Comparison of mean effect of MGTASE enzyme shows that A1 and A2 densities have the highest texture permeation and A3 has the lowest general permeation.

Microbial transglutaminase enzyme creates covalent bonds between proteins and improves the texture and quality of the food products and makes new proteins with new and unique properties. These bonds include Crosslink between lysine from one protein and Glutamine from other protein (Poormohamadi *et al*., 2009). It seems however, that enzyme is also an effective factor so that in this study, enzyme with 0.75% density showed a better texture compared to a 1.5% density.

In another study, microbial transglutaminase enzyme with 0.5, 1 and 1.5% rates were investigated in fish tailor-made product. Results showed that texture and organoleptic features (such as smell, taste and appearance of the product) in weight rate of 1.5 of transglutaminase enzyme had better rates comparing with control sample (Gonkalo & Pasus, 2010).

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