T.R.
VAN YÜZÜNCÜ YIL UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF FOOD ENGINEERING

DETERMINATION OF SOME QUALITY AND FUNCTIONAL CHARACTERISTICS OF GELATIN EXTRACTED FROM CHICKEN SKIN

M. Sc. THESIS

PREPARED BY: Bana FATIH KARIM
SUPERVISOR: Assoc. Prof. Dr. Gökhan BORAN

VAN-2018

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ACCEPTANCE AND APPROVAL

This thesis entitled "**DETERMINATION OF SOME QUALITY AND FUNCTIONAL CHARACTERISTICS OF GELATIN EXTRACTED FROM CHICKEN SKIN**" presented by Bana FATIH KARIM, under the supervision of Dr. Gökhan BORAN in the Department of Food Engineering, has been accepted as a M. Sc. thesis according to the Legislations of the Graduate School on 09/05/2018 with unanimity of voting members of the jury.

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Member: Assoc. Prof. Dr. M. Zeki DURAK Signature:

Member: Assoc. Prof. Dr. Gökhan BORAN Signature:

This thesis has been approved by the Committee of the Institute of Natural and Applied Sciences on / / with the decision number .

Signature :

Prof. Dr. Suat ŞENSOY

Director of the Institute

THESIS STATEMENT

All information presented in the thesis was obtained in the frame of ethical behaviors and academic rules. In addition, relevant literature was fully cited appropriately according to the thesis writing rules implemented by the Institute.

Bana FATIH KARIM

ABSTRACT

DETERMINATION OF SOME QUALITY AND FUNCTIONAL CHARACTERISTICS OF GELATIN EXTRACTED FROM CHICKEN SKIN

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In this study, chicken skin was used for gelatin extraction under predetermined extraction conditions. Some of the quality and functional characteristics of the resultant gelatin was investigated in comparison with commercially available gelatins from different sources. In this regard; gel strength, viscosity, gelling and melting temperatures, water holding and fat binding capacity, foaming and emulsion characteristics were evaluated. Based on the results obtained, chicken skin gelatin showed similar quality and functional characteristics as commercial gelatins in general although some of the parameters were lower in chicken skin gelatin mostly due to insufficient isolation of gelatin and the presence of high amount of impurities in the extracted gelatin under laboratory conditions. While the most of the commercial gelatins showed a gel strength over 400 g, gel strength of chicken skin gelatin was about 300 g. Similarly, its viscosity was lower compared to that of commercial gelatins while its gelling and melting temperatures were practically the same. It is concluded that gelatin extraction under laboratory conditions may require further isolation and purification steps to remove impurities, which greatly interfere with the quality and functional characteristics. On the other hand, chicken skin was proven to be an alternative raw material in gelatin manufacturing for a high quality gelatin when its fat and water was able to be effectively and sufficiently separated.

Keywords: Chicken skin, Functional characteristics, Gelatin, Quality.

ÖZET

TAVUK DERİSİ JELATİNİNİN BAZI KALİTE VE FONKSİYONEL ÖZELLİKLERİNİN BELİRLENMESİ

FATIH KARIM, Bana
Yüksek Lisans Tezi, Gıda Mühendisliği Anabilim Dalı
Tez Danışmanı: Doç. Dr. Gökhan BORAN
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Bu çalışmada, tavuk derisinden daha önce belirlenen ekstraksiyon koşullarına göre jelatin ekstraksiyonu gerçekleştirilmiştir. Elde edilen jelatin bazı kalite ve fonksiyonel özellikleri bakımından farklı kaynaklardan elde edilen ticari jelatinlerle karşılaştırılmıştır. Bu kapsamda; jel gücü, viskozite, jelleşme ve erime sıcaklığı, su tutma ve yağ bağlama kapasitesi, köpük ve emülsiyon özellikleri değerlendirilmiştir. Elde edilen sonuçlara göre, tavuk derisi jelatini genel olarak ticari jelatinlerle benzer kalite ve fonksiyonel özelliklere sahip olmakla birlikte, jelatinin yetersiz izolasyonu ve mevcut safsızlıkların fazla olması nedeniyle laboratuvar koşullarında elde edilen tavuk derisi jelatininde bazı parametreler daha düşük değerler göstermiştir. Ticari jelatinlerin çoğu 400 g değerinin üzerinde bir jel gücü gösterirken, tavuk derisi jelatininin jel gücü 300 g civarında gerçekleşmiştir. Benzer şekilde, ticari jelatinlere göre tavuk derisi jelatininin viskozitesi de düşük ancak erime ve jelleşme sıcaklığı değerlerinin benzer olduğu tespit edilmiştir. Sonuç olarak, kalite ve fonksiyonel özellikler bakımından olumsuz etkileşimlere neden olan safsızlıkların ayrılması için laboratuvar koşullarında jelatin ekstraksiyonunun daha fazla izolasyon ve saflaştırma aşamaları gerektirdiği düşünülmektedir. Diğer taraftan; yağ ve su içeriğinin etkili ve yeterli bir şekilde ayrılabilmesi durumunda tavuk derisinin yüksek kaliteli jelatin ekstraksiyonu için alternatif bir hammadde olabileceği gösterilmiştir.

Anahtar kelimeler: Jelatin, Tavuk derisi, Kalite, Fonksiyonel özellikler.

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Bana FATIH KARIM

Van, 2018

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SYMBOLS AND ABBREVIATIONS

Symbols and abbreviations used in the text were listed below along with their definitions and descriptions.

Symbols	**Definition**
%	Percentage
±	Plus or minus
°C	Centigrade celsius

Abbreviations	**Definition**
h	Hour
min	Minute
s	Second
EAI	Emulsion Activity Index
ESI	Emulsion Stability Index
TPA	Texture Profile Analysis
WHC	Water Holding Capacity
FBC	Fat Binding Capacity
FC	Foaming Capacity
FS	Foaming Stability
CSG	Chicken Skin Gelatin
BHG-S	Bovine Hide Gelatin-SELJEL
BHG-H	Bovine Hide Gelatin-HALAVET
BHG-G	Bovine Hide Gelatin-GERMANY

PSG	Pork Skin Gelatin
FSG	Fish Skin Gelatin

1. INTRODUCTION

1.1. Research Background

Gelatin is a multi functional hydrocolloid derived from collagen, which is a natural animal protein and found densely in skin and bones of animals like cattle, pig, chicken and fish (Boran, 2011). Gelatin is produced from cattle skin and bone, fish skin, chicken skin and bone but commercially, mostly from pig skin and bones. The major step in gelatin production is to partially hydrolyze collagen to obtain low molecular weight collagen fractions, which are water soluble, on the contrary of the source molecule, collagen (Boran, 2011). Although gelatin is mostly obtained from the skins and bones of pigs and cattles, there are other alternative raw materials used in gelatin manufacturing including byproducts from the chicken and fish processing industries. Fish skin has received attention from researchers as an alternative raw material having a potential for the production of high quality gelatin. Therefore, recent studies with fish skin gelatin have focused on the evaluation of different fish species as an alternative raw material for gelatin production and the quality of extracted gelatins in comparison with commercial gelatins from conventional sources (Boran and Regenstein, 2009).

Gelatin contain high amount of certain aminoacids such as glycine, proline and hydroxyproline (Gilsenan and Ross-Murphy, 2000; Arnesen and Gildberg, 2007) but low in cysteine, methionine and tyrosine (Chapman and Hall, 1997; Jamilah and Harfinder, 2002). Gly-X-Y is the typical sequence of amino acid in gelatin which represents Gly as glycine, X is proline and Y is hydroxyproline. The most abundant amino acid in gelatin is glycine. 25% of dry gelatin contains proline and hydroxyproline which can stabilize its structure (Russell et al., 2007). Gelatin has been widely used in food, pharmaceutical, photographic, and cosmetic industries (Karim and Bahat, 2009). In food industry, gelatin is used as an ingredient to improve elasticity, consistency and stability of food like deserts, candies, bakery product, jellied meats, ice cream and dairy products. Gelatin also used as stabilizer to modify the structure of the food product. Gelatin is added to yogurt to reduce syneresis and increase firmness. Different concentrations of gelatin would give a wide range of textures in food products. Gelatin

is compatible with milk proteins and can improve the taste of cakes and marshmallow. In pharmaceutical industry, it can be used for encapsulation, production of hard and soft capsules, wound dressing and emulsions (Djagny et al., 2001). In photographic applications, gelatin is used for lighting equipment which is the color gel use to change the beam color. For cosmetic usage, gelatin can be used as styling gel usually use by swimmer to hold their hair in place because gelatin is not dissolved in cool water or pool. It also can be used as nail polish remover and make up application. Other than that, a lot of beauty products use collagen in their formulations for whitening, repairing skin damage and some goods for repairing body tissue.

Because of its high value and its wide use in different fields, gelatin production has been always popular and getting interest from researchers. Alternative raw materials, which are rich in collagen, can be utilized in gelatin production. In this regard, polutlry byproducts may be one alternative. Poultry processing industry has recently growed substantially throughout the world, leading to availability of a huge amount of processing byproducts, of which can be evaluated in many different ways. Using in gelatin production may be one alternative due to high amount of collagen presents in these waste materials. Especially, converting poultry into highly processed food products like grill marked chicken products, chicken burgers and patties, and many others leads to a portion over 50% of the bird to be considered as waste. Therefore, evaluation of these waste materials is becoming more challenging from day to day and gelatin like high profit and high value end products may be fisibly and profitably obtained from these byproducts.

There are many properties that affect the quality and functionality of gelatin. Some of the physical attributes include gel strength, viscosity, melting and gelling temperatures while functional characteristics include emulsion capacity and stability index, foaming capacity and stability, fat binding and water holding capacity, etc. Gelatin quality and its market value is, the most of the time, evaluated by gel strength or Bloom value, ranging from low (<150), medium (150–220) to high Bloom (220–300) levels. Commercially, high viscosity gelatin is preferred and comes up with a higher market price. And these two important attributes of gelatin, gel strength and viscosity, are greatly affected by amino acid composition, molecular weight distribution and triple helix formation (Gomez-Guillen et al., 2002).

Alkali and acid treatment are required before the hydrolysis of collagen into gelatin. The function of alkali treatment is to remove non-collagenous proteins and pigments. Another function is to weaken the collagen structure leading to higher quality of gelatin. In most of the acid extraction processes, citric acid is used because it does not change the texture of gelatin in terms of color or odor. Acid treatment will effectively remove odors and color from the raw material (Boran and Regenstein, 2009). It is essential to optimize conditions of these pretreatments and the follow up extraction processes for high yield and quality. And lately, many researches have appeared on this issue, optimization of extraction conditions for gelatin extraction from alternative resources and evaluation of alternative raw materials in gelatin manufacturing.

1.2. Significance and Justification of the Study

Poultry byproducts has recently gained attention from researchers as alternative raw materials in gelatin manufacturing as poultry industry lately jumped to the another level and has been dramatically shifted into further processed poultry products, leading to the production of byproducts in higher levels. Chicken skin is one of those byproducts, which may be considered as a resource for gelatin production due to its high level of connective tissue protein along with its high level of fat and water. There is no report on gelatin extraction from chicken skin, evaluating its potential and making a through comparison with commercially available gelatin from different sources. Therefore, this study was intended to evaluate the potential use of chicken skin, as one of the byproducts from poultry processing industry, in gelatin manufacturing and its quality and functional characteristics in comparison with commercial gelatins from different sources.

Gelatin, one of the most popular biopolymers, is widely used in food, pharmaceutical, cosmetic, and photographic applications because of its unique functional and technological properties (Gomez-Guillen et al., 2011). On the other hand, the focus on gelatin alternatives has increased recently as the demand for non-bovine and non-porcine gelatin has increased due to religious and social reasons (Badii and Howell, 2006). Therefore, use of gelatin alternatives or alternative raw materials in

gelatin production is highly desirable to food processors as the global market for Halal and/or Kosher certified food is growing rapidly (Karim and Bhat, 2009).

Food gels are viscoelastic substances and several gelled products are manufactured throughout the world. The gelling agents in foods are usually polysaccharides and proteins. In food gels, the polymer molecules are not cross-linked by covalent bonds with the exception of disulphide bonds in some protein gels. Instead, the molecules are held together by a combination of weak inter-molecular forces like hydrogen bonds, electrostatic forces, Van der Waals forces, and hydrophobic interactions. Polysaccharides including hydrocolloids are strongly hydrated in aqueous medium but they tend to have less ordered structures. The mechanism of gelation depends on the nature of the gelling agent(s) and on the conditions of gel formation like the temperature, the presence of ions, the pH, and the concentration of gelling agents, etc. Characterization of gels can be performed in several ways of which rheological measurements are frequently practiced. Multi-component or mixed gel system is an important area of interest in which two or more gelling components are simultaneously used to achieve certain specific structural and functional characteristics (Banerjee and Bhattacharya, 2012).

Chicken skin is usually converted into animal feed, whereas a smaller proportion is used for incorporation into meat emulsions or used as a source of fat mainly for soup formulations. As chicken skin is rich in terms of fat and relatively poor in protein, its use in gelatin production can be challenging (Schrieber and Garies, 2007). However; chicken skin, if its fat and water content can effectively be dimished and its collagen is sufficiently isolated, may be utilized as an alternative resource in gelatin manufacturing. Therefore, this study is designed to utilize chicken skin in gelatin production and to compare resultant gelatin with commercially available gelatins from different sources.

2. LITERATURE REVIEW

The acid treatment is usually used for gelatin extraction from collagen rich tissues of young animals with relatively short period of time of application while alkaline treatment is frequently used for mature animals with a complex structure of connective tissue for longer application durations. According to Hao et al. (2009), the quality of gelatin depends on its physical properties, which is influenced by both species-specific characteristics and tissue, from which the gelatin is extracted. Extraction method and extraction conditions are also effective on the quality of the resultant gelatin. Gelatin obtained by acid treatment from bone meal was kinetically investigated by Nicolas-Simonnot et al. (1997). They determined that bone particle size, pH and extraction temperature were important on extraction efficiency. The extraction temperature was also determined to be a significant extraction parameter in this study.

In the study by Muyonga et al. (2004), gelatin was obtained from fish skin and bone with acid extraction and these gelatins were compared in terms of quality characteristic and functional properties. According to the results, it was seen that bone gelatin requires higher heat treatments and the extraction efficiency from bone was lower compared to that of skin. This was because of the necessity of removing inorganic matters from the bone structure, which decreases yield and quality. In the study by Shakila et al. (2012), gelatin was obtained from two different fish bone via a standard method and these gelatins were compared with commercial gelatins obtained from traditional sources in terms of quality characteristic and functional properties. The fish bone gelatin showed outstanding functionalities compared to gelatin obtained from traditional sources. Nearly 10% of extraction yield was obtained from both fish bone materials.

One of the few studies on chicken gelatin by Sarbon et al. (2013), gelatin was obtained from chicken skin and it was compared with cattle gelatin in respect to their physicochemical characteristics. The results obtained revealed that the chicken skin gelatin showed higher gel strength than bovine hide gelatin. The dynamic viscoelastic properties of chicken skin gelatin exhibited higher viscous and elastic modulus compared to bovine hide gelatin. Gelatin was extracted from chicken skin and

characterized in terms of yield, molecular weight, melting point and viscosity. The yield of gelatin using acetic and nitric acid were 11.2 and 9.2% (w/w), respectively, based on dry weight. Both gelatins showed the same molecular weight patterns based on SDS-PAGE analysis. Fish gelatin obtained in the study by Irwandi et al. (2009), showed similar characteristics to the fish gelatins from other fish species previously reported. The gelatin extracted from “kerapu” had the strongest fishy odor, followed by the gelatins derived from “jenahak”, “kembung” and “kerisi”. In terms of bloom strength, the gelatin extracted from “kerapu” was found to be the strongest compared to others. Gelatin was extracted from catfish skin and the resultant gelatin showed high protein content (88.46 g/100 g) with a viscosity of 3.5 mPa s, 286.7 g gel strength and presence of 173 residues of imino acids (proline and hydroxyproline) per 1000 residues. Furthermore, gelatin from catfish skin showed a relatively good textural quality according to texture profile analysis (Ardekani et al., 2013).

The yield of acid and pepsin soluble collagens from the scales were investigated by Dinçer et al. (2015). Both collagens were characterized as Type I collagen, containing α-1 and α-2 chains. Gelatin was recovered from scales of farmed sea bass using acetic acid as solvent. Protein content of the resultant value was reported to be 96% and the yield was found to be 18.5%. Gel strength and viscosity was 305 g and 33 cP, respectively. Fourier transform infrared spectroscopic analysis showed characteristics similar to that of gelatin from bovine hide (Dinçer et al., 2015). Nik Aisyah et al. (2014) studied gelatin from chicken skin and concluded that chicken skin was higher in glycine, hyproxyproline and proline content and exhibit higher thermal stability compared to mammalian and fish gelatins.

In a study by Widyasari and Rawdkuen (2014), the highest yield of chicken feet gelatin was obtained from acid extraction method with 4.05% (wet weight or 12.64% based on dry weight). Proximate composition of chicken feet gelatin showed the acid extraction lead to higher protein content than ultrasound assisted extraction with 90.1% while ultrasound assisted gelatin resulted in the lowest water content with 5.4%. pH of gelatin solution from both methods ranged between 6.1 and 6.5.

Mechanical compression was used to study the gelling characteristics of gelatin gels. Texture profile analysis showed that the hardness of fish and mammalian gelatin increased significantly as the concentrations of gels increased. Textural attributes of

10% fish skin gel showed significant differences from those obtained from 20 and 30% gels. In bovine and porcine cases, such generic trends were not observed. Mechanical characteristics of 10% gels of gelatin from fish skin, determined from one cycle compression, were significantly lower than other sources of gelatin gels, while bovine and porcine gels did not show any significant difference. In the case of TPA, hardness of bovine gelatin gel was the highest at 41 N for 10% gel, followed by porcine (30 N) then fish skin (5 N) gelatin gels. The gels prepared from different sources did not show any generic trends when all other mechanical attributes were considered (Shafiur Rahman and Al-Mahrouqi, 2009).

Poultry byproducts are of great importance as the poultry industry is growing rapidly. The processing wastes from poultry industry are valuable due to their high level of fat and protein. As one those wastes, chicken skin should be considered for utilization in production of alternative products. Gelatin production may be one alternative as chicken skin has over 10% protein, the most of which is collagen, when its fat content is effectively and sufficiently diminished.

3. MATERIAL AND METHODS

3.1. Material

The chicken skin (Figure 3.1.) was provided by a local meat market in Van province, Turkey. Fresh skin samples was brought to the laboratory; separated from observable fat and meat residues using a knife. Then, samples were ground using meat grinder and kept at -18°C in 50 g portions within freezer bags until further use. For comparison, five of commercially available gelatins from different sources like fish skin, pork skin and bovine hide were obtained from Jiliding Marine Biotech (Jiangsu, China), Warenhandel (Neckarsulm, Germany), M-Haditech (Bremen, Germany), Halavet (Istanbul, Turkey), and Seljel (Balıkesir, Turkey), respectively. Therefore, five commercial gelatin samples were used for comparison, namely Fish Skin Gelatin (FSG), Pork Skin Gelatin (PSG) and three of Bovine Hide Gelatins from different manufacturers (BHG-G, BHG-H and BHG-S stand for Bovine Hide Gelatin from Germany, Halavet and Seljel, respectively).

(A) (B)

Figure 3.1. Study material, fresh chicken skin, (A) Chicken skin as obtained from the meat store, (B) Chicken skin, trimmed for fat and meat residues.

Skin samples were used for gelatin extraction according to the procedure determined in a previous study (Yıldız, 2017). First, collagen was isolated removing fat and water, two of which were the other two significant components along with protein. Later on, gelatin extraction was carried out according to the predetermined pretreatment

and extraction conditions for the highest yield and quality. Lastly, quality and functional characteristics of gelatin obtained were determined and evaluated in comparison with commercial gelatins from different sources. All chemicals used in this study were of analytical grade and obtained from Sigma (MO, USA) and Merck (NJ, USA). All analysis were done in triplicate unless otherwise was stated.

3.2. Methods

3.2.1. Gelatin extraction

Chicken skin was used in gelatin extraction after trimming of excessive fat and meat residues. Gelatin extraction was carried out according to the procedure given by Yıldız (2017) after slight modifications (Figure 3.2.).

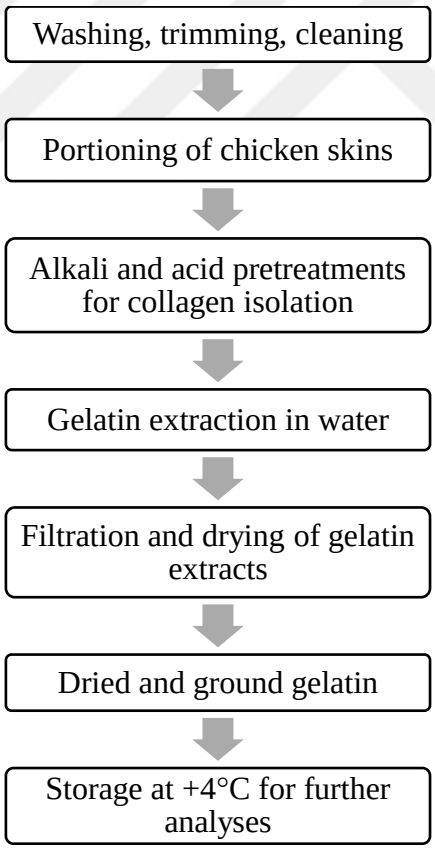


Figure 3.2. Process flow for collagen isolation and gelatin extraction from chicken skin.

Prepared skin samples were treated with dilute alkali (0.1 N NaOH) and acid (0.1 N HCl) at room temperature for 3 h, respectively. Following that, gelatin extraction was carried out in distilled water at 55°C for 7 h. Finally, gelatin extracts were dried at 50°C in plastic pans and ground to obtain dry gelatin. Schematic process flow of this procedure was given in Figure 3.2. When dry gelatin sample was ready, it was stored at 4°C along with other commercial gelatins in the refrigerator until further analyses were performed, which typically took about 1 to 2 weeks. All gelatin samples were food grade.

3.2.2. Quality characteristic of the samples

3.2.2.1. Gel strength

Gelatin samples were first dissolved in distilled water at a weight based concentration of 6.67% using a waterbath at 60°C for ease of dissolution. Then, gelatin solutions were matured at 4°C for 16-18 h for gel formation in polipropylen capped 50 mL containers. Penetration test was performed onto gelatin gels using a texture analyzer (Texture Technologies, Hamilton, MA, USA) equipped with 12.7 mm diameter cylindrical probe. Penetration speed was set at 0.5 mm/s. The force required for 4 mm penetaration was given as gel strength in g (BSI, 1975).

3.2.2.2. Viscosity

Gelatin solutions were prepared as given above. Viscosity of these solutions was measured using a Cannon Fenske Routine Calibrated Viscometer (CANNON, State College, PA, USA), which was held in a waterbath at 60°C. 10 mL of gelatin solutions were taken and transferred into glass viscometer and then waited for 5 minutes for temperature equilibration. After that, sample's transition velocity through viscometer was measured and used for calculation of the viscosity in cP according to the formulations given below (GMIA, 1986).

Kinematic Viscosity (mm^2/s) = Transition Velocity (s) × Viscometer Constant (mm^2/s^2)

Viscosity (cP) = Kinematic Viscosity (mm^2/s) × Density (g/mL)

3.2.2.3. Melting and gelling temperature

Gelatin solutions were prepared according to the procedure given above. A rotational rheometer (Brookfield, Middleboro, MA, USA) equipped with SC4-27 cylindirical probe was used at a rotation speed of 40 rpm. A temperature sweep test was carried out from 40 to 5 and again to 40°C at a rate about 1°C/min, in where viscosity was recorded in every 10 s intervals. The temperature, at where an evident viscosity change can be seen, was observed as the melting temperature while cooling from 40 to 5°C and vice versa for the gelling temperature (Kołodziejska et al., 2008; Arnesen and Gildberg, 2007).

3.2.2.4. Transparency and pH

Gelatin solutions were prepared as described previously. Gelatin solutions were used for transparency measurement using a UV-VIS spectrophotometer (UV-Mini 1240 UV-VIS, Shimadzu, Kyoto, Japan) at 640 nm and expressed in %. For pH measurement, gelatin solutions were prepared as described previously except the concentration, which was 1%. pH of the solutions were measured using a portable multi meter (SG23 SevenGO, Mettler Toledo, OH, USA) at room temperature.

3.2.3. Functional properties of the samples

3.2.3.1. Water holding capacity

Firstly, 10 mg gelatin was weighed in centrifuge tube and mixed with 0.5 mL of distilled water for measuring water holding capacity (WHC). Resultant solution was mixed every 15 min for 5 s using vortex mixer (Vortex Mixer Classic, VELP, Usmate, Italy). After this was continued for 1 h, content in the tube was centrifuged at room temperature at 450 ×g for 20 minutes. The content was filtered on filter paper for 30 min and weighed. WHC was calculated according to the formula below (Cho et al., 2004).

%WHC = {[Pellet weight (mg) – Gelatin weight (mg)] / Gelatin weight (mg)} × 100

3.2.3.2. Fat binding capacity

Measurement of fat binding capacity (FBC) was carried out according to the procedure given for WHC above except sunflower oil was used replacing water. 10 mg gelatin was weighed in centrifuge tube and mixed with 0.1 mL of sunflower oil. The mix was vortexed for 1 h in total in every 15 min for 5 s. This mix was centrifuged at room temperature at 450 ×g for 20 min. After that, it was filtered for 30 min on filter paper and weighed. FBC was given according to the following formula (Cho et al., 2004).

%FBC = {[Pellet weight (mg) – Gelatin weight (mg)] / Gelatin weight (mg)} × 100

3.2.3.3. Foaming capacity and stability

1% (w/v) gelatin solution was prepared with distilled water and dissolved at 60°C. Prepared gelatin solution was mixed on a hot plate with magnetic stirrer for 30 minutes and transferred to a 100 mL volumetric cylinder. Volume of the solution was immediately read and reading was repeated after 30 and 60 min. Foaming capacity (FC) and stability (FS) were calculated according to the formulas below (Cho et al., 2004).

%FC = {[SV0 (mL) – SV (mL)] / SV (mL)} × 100
%FS30 = {SV30 (mL) / SV0 (mL)]} × 100
%FS60 = {SV60 (mL) / SV0 (mL)]} × 100

SV: Initial solution volume (mL)
SV0: Solution volume shortly after homogenization (mL)
SV30: Solution volume after 30 min of homogenization (mL)
SV60: Solution volume after 60 min of homogenization (mL)

3.2.3.4. Emulsion activity and stability index

30 mg of gelatin was weighed and homogenized with 10 mL of sunflower oil at room temperature for 1 min. 50 μL was taken from this solution and diluted 100 times with 1% sodium dodecyl sulphate solution. That was vortexed for 10 s and then samples were taken from diluted solution shortly after homogenization and 10 min later. These samples were used for measurement of the absorbance at 500 nm and the results were calculated according to formulas given below for emulsion activity index (EAI) and emulsion stability index (ESI) (Pearce and Kinsella, 1978).

$EAI\ (m^2/g) = (2 \times 2.303 \times A0 \times N) / (c \times ø \times 10.000)$

$ESI\ (min) = (A0 \times 10) / (A0 - A10)$

A0: Absorbance shortly after homogenization

A10: Absorbance after 10 min of homogenization

3.2.3.5. Texture profile analysis

Gelatin gels were prepared as mentioned previously. After that, matured gel samples were taken off from the containers and used for texture profile analysis (TPA) using texture analyzer equipped with a circular probe with a diameter of 50 mm. 20 mm long samples were pressed at a level of 20% compression to obtain a TPA graph. TPA parameters like hardness, springiness, adhesiveness and chewiness were calculated based on this graph (Bourne, 2002).

3.2.4. Statistical analysis

The results obtained were statistically analyzed using JMP 8.0 statistic software (SAS, NC, USA). ANOVA was performed for determination of significant differences among the samples and as a follow up test, Tukey test was utilized to determine which pairs were significantly different at a probability level of 0.05.

4. RESULTS AND DISCUSSION

4.1. Gelatin Extraction and the Resultant Gelatin

Chicken skin used and the resultant gelatin obtained in the study was visiualized in Figure 4.1. Proximate composition of the starting material, chicken skin, was about 51.5% water, 35.0% fat, 11.5% protein and 0.6% mineral. Based on this, it was obvious that chicken skin was rich in fat, which was needed to be removed along with water for the purpose of protein isolation. After successive isolation procedures, composition of the resultant gelatin was about 9.1% water, 7.3% fat, 71.7% protein and 3.1% mineral. As seen from this, fat and mineral content of the gelatin obtained was very high compared to commercial standards. On the other hand, gelatin extraction performed under laboratory conditions without utilizing sophisticated bioseparation techniques was still a success up to a reasonable level when protein content of the gelatin was considered. If further removal of fat and minerals could become possible, the resultant gelatin would be high in quality and then a fair comparison would be made.

(A) (B) (C) (D)

Figure 4.1. Chicken skin as obtained from the meat market (A), Trimmed and pretreated chicken skin (B), Gelatin solution obtained by extraction (C), Dried gelatin extracts (D).

Gelatin gels prepared from chicken skin obtained in this study and those obtained from the market were given in Figure 4.2. There were significant differences in color but not much in transparency among the commercial samples, while transparency of the CSG gels was an issue. These were the samples, on which gel strength and TPA measurements were performed immediately after removing from the refrigerator at 4°C.

For TPA measurements, the gel samples were taken out of the container while the samples were tested as they were in the container for gel strength measurements.

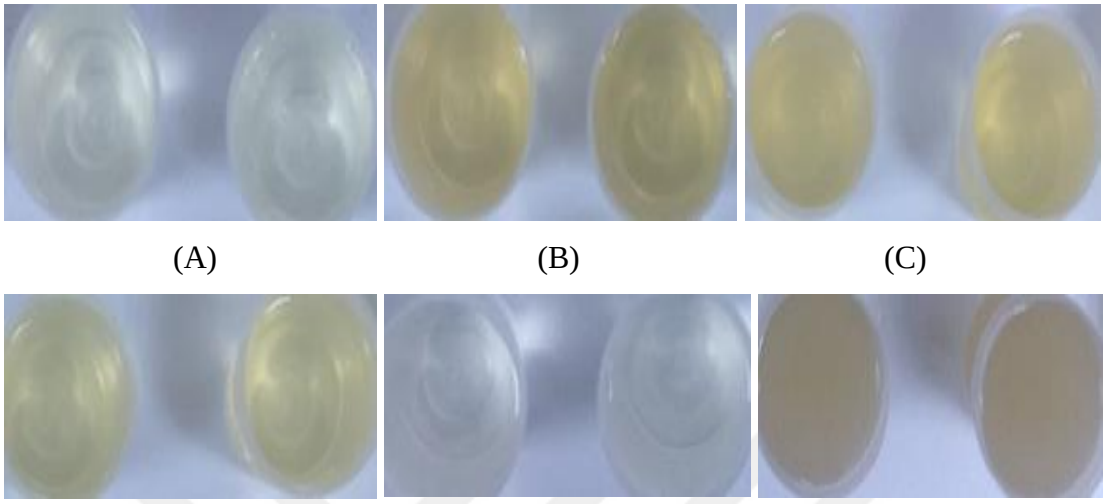
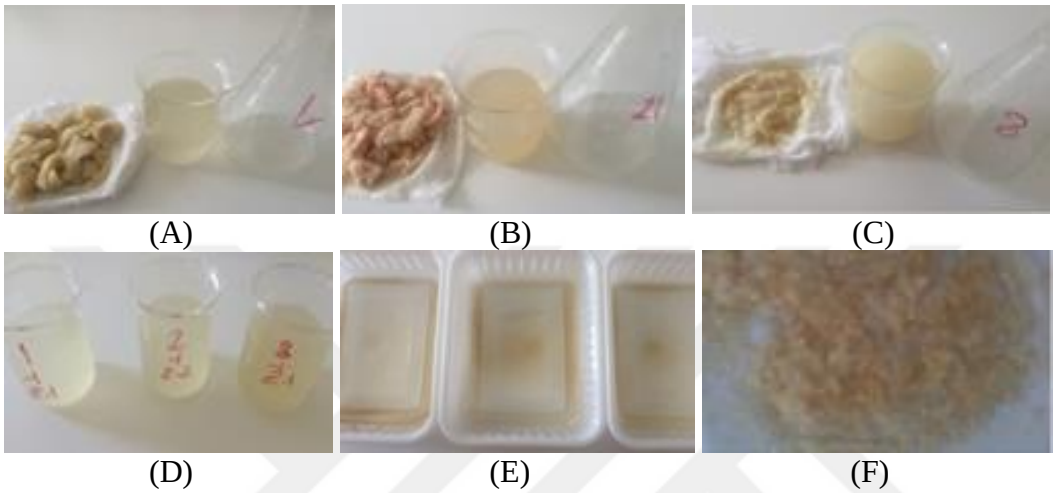


Figure 4.2. Gelatin gels prepared with samples from different sources: (A) Pork skin (Germany), (B) Bovine hide (Halavet, Turkey), (C) Bovine hide (Seljel, Turkey), (D) Bovine hide (Germany), (E) Fish skin (China), (F) Chicken skin (this study).

As seen from Figure 4.2., chicken skin gelatin was not transparent compared to the gels of commercial gelatins from different sources. As fat and mineral content of chicken skin gelatin obtained in this study were high and at unacceptable levels according to the commercial standards, transparency and other quality parameters of this sample were interfered. A previously optimized extraction procedure was performed to obtain CSG. However, this procedure was still insufficient for removal of fat and minerals at acceptable levels. Meanwhile, this study was to show the potential of chicken skin as a raw material for gelatin production. And, this was accomplished by obtaining a gellable extract high in protein, despite of high amount of impurities.

Photographs from alkali and acid treatments, gelatin extraction and resultant solutions, and finally chicken skin gelatin obtained in this study can be seen in Figure 4.3. The whole procedure can be summarized in three consequitive steps, namely pretreatments of alkali and acid washings, gelatin extraction in distilled water and finally drying and grinding. As obvious and given in the process flow, the raw material was processed for its fat and water content with the purpose of collagen isolation aiming

a high yield and quality gelatin extraction. As given, chicken skin was rich in fat and water, consitituing over 80% of fresh chicken skin. In its dry matter, the fat was the most significant constituent after the protein being the second in amount. Therefore, fat removal was crucial in isolation of collagen and for making possible to extract high quality gelatin at the end.



(A) (B) (C)

(D) (E) (F)

Figure 4.3. Some photos from gelatin extraction: (A) Alkali treatment; remaining skin and solution of the residues, (B) Acid treatment; remaining skin and solution of the residues, (C) Gelatin extraction; resultant skin and gelatin solution, (D) Gelatin solutions obtained after extraction, (E) Dried gelatin films, (F) Ground dry gelatin.

Figure 4.3. visualized that gelatin obtained was yellowish and high in fat. In fact, the proximate composition of the resultant gelatin revealed that there was over 7% of fat and 3% of minerals in the sample that was unacceptable according to the commercial standards. However, other quality characteristics and functional properties of gelatin obtained showed that chicken skin may be a promising alternative in gelatin manufacturing.

4.2. Quality Characteristics of Gelatin Samples

Quality characteristics including gel strength, viscosity, melting and gelling temperatures of the gelatin samples were given in Table 4.1 and Figure 4.4. On the other hand, measurements on transparancey and pH of the samples were given in Figure 4.5.

Table 4.1. Some quality characteristics of gelatin extracted from chicken skin in comparison with commercially available gelatins from different sources

	CSG (This Study)	BHG-S (Seljel)	BHG-H (Halavet)	BHG-G (Germany)	FSG (China)	PSG (Germany)
Gel strength (g)	306.8 (±8.8)	410.9 (±6.5)	415.1 (±13.5)	301.0 (±6.2)	560.7 (±45.6)	431.9 (±7.5)
Viscosity (cP)	2.50 (±0.00)	3.85 (±0.05)	4.05 (±0.06)	5.42 (±0.04)	4.62 (±0.02)	4.66 (±0.02)
Melting temp. (°C)	29.5 (±0.8)	30.2 (±0.3)	30.0 (±0.7)	28.5 (±0.7)	26.8 (±0.2)	30.7 (±0.3)
Gelling temp. (°C)	19.0 (±0.0)	19.2 (±0.3)	20.0 (±0.0)	18.7 (±0.3)	16.7 (±0.2)	20.5 (0.0)

Results were given in average±standard deviation.

4.2.1. Gel strength

As seen from Table 4.1., gel strength of CSG obtained in this study was mostly lower compared to the other commercial gelatins except BHG-G obtained from a manufacturer from Germany, most probably due to impurities left in chicken gelatin extracted in this study, because of a relatively ineffective separation of impurities under laboratory conditions compared to the unit processes utilized in a commercial gelatin manufacturing plant.

Gel strength is probably the most important physical characteristic of gelatin (Cheow et al. 2007). The quality and selling price of a gelatin, the most of the times, is determined base on its gel strength or Bloom value (Schrieber and Gareis 2007). In general, high value of gel strength means good quality gelatin (Cho et al. 2005). In this study, gel strength of CSG and BHG-H were around 300 g, relatively low compared to that of other samples.

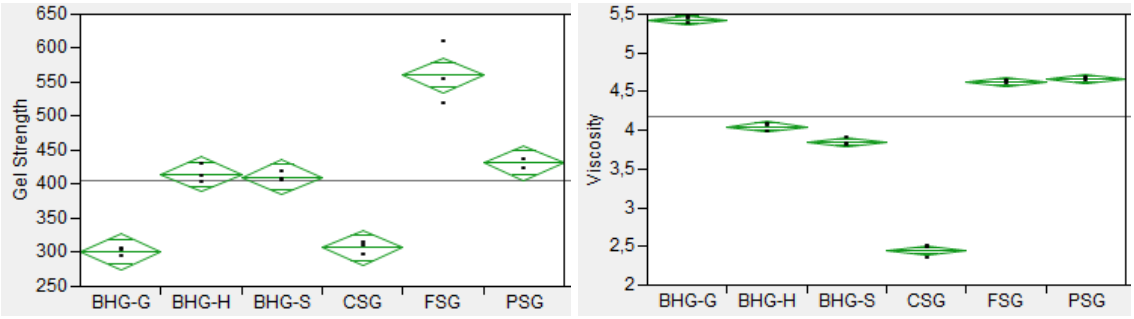
4.2.2. Viscosity

The second most important physical characteristic is viscosity (Jamilah and Harvinder, 2002) that was measured by Cannon Fenske Routine Viscometer which was held in waterbath at 60°C. Viscosity of CSG was 2.5 cP, which was lower than that of other gelatins. It was obvious that protein in CSG obtained was not sufficiently isolated

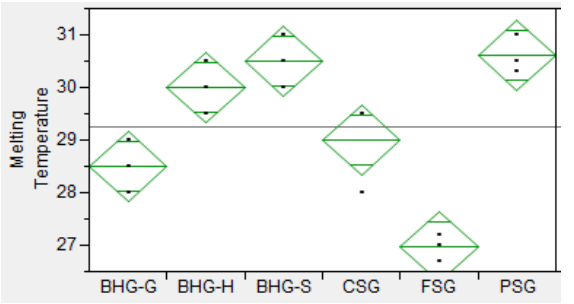
and as there were lots of impurities in the gelatin sample, its viscosity and gel strength were much lower compared to other commercial samples. With regard to the gel strength and viscosity, CSG showed a similar gel strength with BHG-G although they were significantly different from other four of the samples ($P<0.05$). Viscosity of CSG, on the other hand, was lower and significantly different from all other samples although the difference between PSG and FSG was not significant.

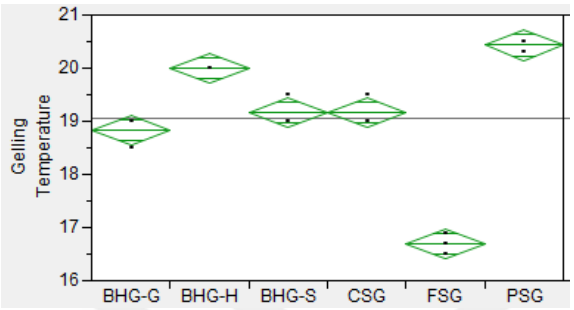
4.2.3. Melting and gelling temperature

Melting and gelling tempereratures of the samples showed oscillation within a relatively narrow gap. As seen from the Table 4.1., the gelling temperature of CSG was not significantly different from that of BHG-S and BHG-G while they were significantly different from other three samples, BHG-H, PSG and FSG ($P<0.05$). On the other hand, the melting temperature of CSG was similar to that of BHG-H while they were significantly different from other four samples ($P<0.05$). However, an overall evaluation of the values, in terms of gelling and melting temperatures, showed that there was not much difference among the samples.



(A) (B)





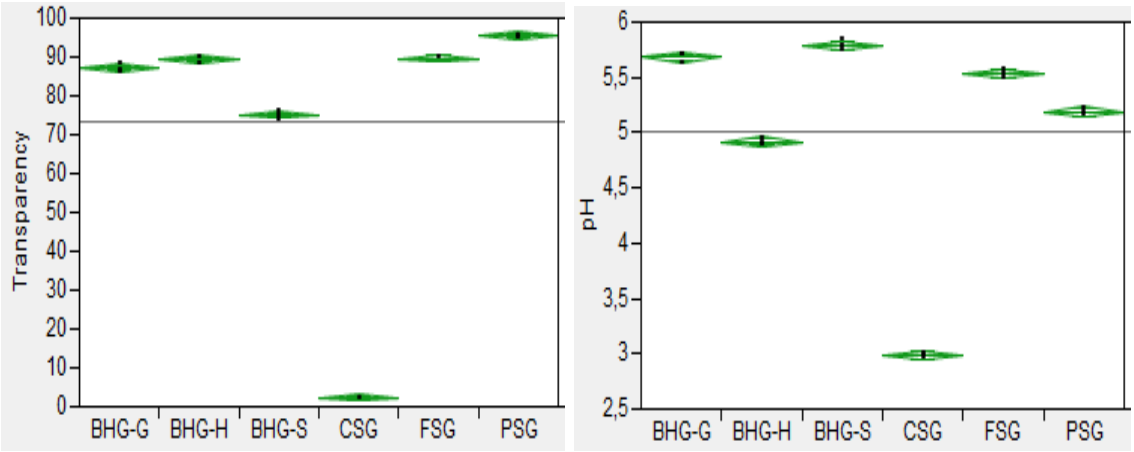
(C) (D)

Figure 4.4. Quality characteristics of gelatin samples: (A) Gel strength in g, (B) Viscosity in cP, (C) Melting temperature in °C, (D) Gelling temperature in °C.

Figure 4.4. shows mean values and variation for the quality characteristics of the samples studied. Variation of all the measurements can be considerd as reasonable and acceptable. As mentioned above, melting and gelling temperatures of CSG were similar when compared to commercial samples however, especially viscosity was very low in CSG, which may be attributed to the impurities, as seen from the color and transparency of the sample. On the other hand, the presence of impurities also contributed to reasonable gel strength and moderate gelling and melting temperatures by playing a role in binding between different active sites of the collagen fractions and other compounds within the solution environment.

4.2.4. Transparency and pH

Results on pH and transparancey of gelatin solutions were given in Figure 4.5. According to the results, pH of CSG was dramatically lower compared to the values obtained for commercial gelatin samples, which was most probably due to high content of impurities and insufficient neutralization after alkali and acid pretreatments carried out before gelatin extraction in CSG.



(A) (B)

Figure 4.5. Transparency and pH of gelatin samples: (A) Transparency of the gelatin solutions, (B) pH values of the gelatin solutions.

pH of all samples was around 5.5 while transparency of the gelatin samples were quite high and around 90% except CSG. Low transparency of CSG was thought to be due to the impurities and high fat and mineral content. In case of pH, on the other hand, alkali and acid washings before gelatin extraction and consequient neutralization was thought to be insufficient, leading to a high proton concentration in its solution. Although pH and transparency of commercial gelatin samples were similar, they were all significantly different ($P<0.05$) from each other except that BHG-H and FSG had no significant difference in transparency.

4.3. Functional Properties of Gelatin Samples

Functional properties including water holding and fat binding capacity, foaming and emulsion characteristics of gelatin samples were summarized in Table 4.2. CSG showed generally lower water and fat binding abilities while its foaming and emulsion characteristics, generally speaking, were similar or superior compared to other samples.

Table 4.2. Some functional properties of gelatin extracted from chicken skin in comparison with commercially available gelatins from different sources

	CSG (This Study)	BHG-S (Seljel)	BHG-H (Halavet)	BHG-G (Germany)	FSG (China)	PSG (Germany)
WHC (%)	683	1237	1026	843	1209	-

	(±49)	(±39)	(±14)	(±40)	(±3)	
FBC (%)	116 (±6)	222 (±3)	228 (±4)	258 (±3)	233 (±2)	-
FC (%)	20.0 (±0.0)	34.6 (±2.3)	43.3 (±1.1)	53.3 (±1.1)	66.6 (±2.3)	42.0 (±2.0)
FS30 (%)	83.3 (±0.0)	83.1 (±0.7)	70.2 (±0.7)	77.8 (±1.1)	68.4 (±0.6)	87.7 (±0.8)
FS60 (%)	83.3 (±0.0)	74.2 (±1.2)	69.7 (±0.5)	73.4 (±1.9)	62.0 (±1.0)	82.6 (±2.0)
EAI (m^2/g)	72.8 (±0.7)	65.5 (±3.5)	63.5 (±3.1)	63.1 (±2.2)	66.5 (±1.3)	56.0 (±3.1)
ESI (min)	12.7 (±0.2)	12.9 (±0.5)	12.4 (±0.7)	11.7 (±0.5)	13.4 (±1.1)	11.1 (±0.1)

Results were given in average±standard deviation. As gelatin sample from pork skin was not sufficient in amount, WHC and FBC analyses were not conducted on this sample.

Based on the results obtained, there seems to be great differences among the samples in terms of water holding capacity, fat binding capacity, foaming and emulsion characteristics. This was thought to be mostly because of the impurities in the extracted gelatin compared to the other commercial samples. Commercial samples did not show great differences among themselves while CSG was greatly different from these samples in general. Foaming and emulsion characteristics of CSG were similar and in fact superior in some cases, compared to the other samples although FC, WHC and FBC of this sample were significantly lower than that of other samples ($P<0.05$).

4.3.1. Water holding capacity

WHC and FBC were significantly different between CSG obtained in this study and other gelatins (Figure 4.6.). In general terms, it may be easily claimed that impurities in CSG resulted in lower WHC and FBC as these impurities interfere with binding capability of collagen fractions. While WHC of BHG-S and FSG were almost identical, BHG-G and BHG-H showed lower WHC values compared to that of the aforementioned two samples.

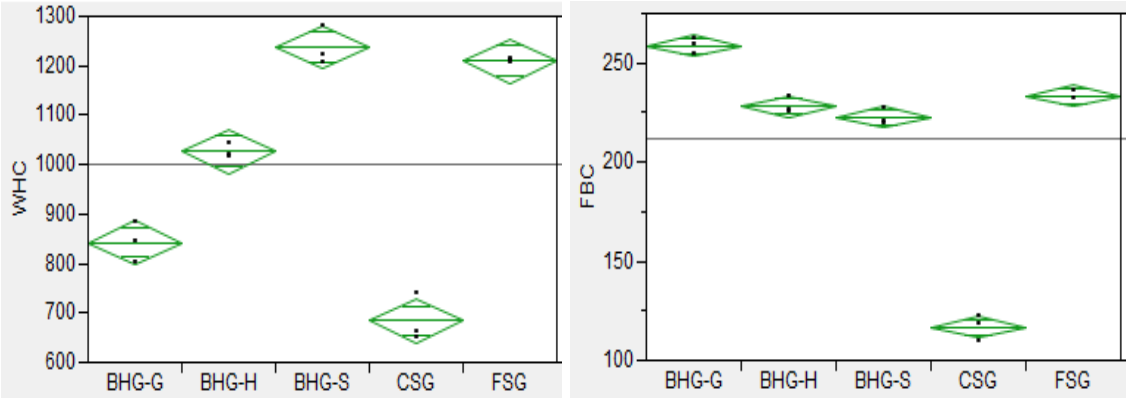


Figure 4.6. Water holding and fat binding capacity of gelatin samples.

4.3.2. Fat binding capacity

As seen from Figure 4.6., FBC of chicken skin gelatin extracted was significantly different and lower compared to the other samples. This may be attributed to already high content of fat in CSG sample, which make difficult to adsorb more fat within the structure. On the other hand, the presence of other impurites other than fat might have been helpful for a reasonable level of FBC covering fat globules, creating and stabilizing a colloidial network structure. Other gelatins including FSG, BHG-H and BHG-S were almost identical in FBC while BHG-G was superior compared to the rest of the samples.

4.3.3. Fomaing capacity and stability

Considering foaming properties of the samples, it was obvious that FC of CSG was very low and significantly different from all other samples. However, foaming stability of the same sample showed higher values compared to other samples. Once foam was formed, it was more stable in CSG compared to the most of the samples. Remarkably, PSG showed high foaming stability similar with CSG although FC of both samples were relatively low. Figure 4.7. shows mean values and variations in FC, FS30 and FS60 values. Generally, all three bovine hide gelatins showed significantly different foaming characteristics while FSG had the lowest foaming stability and the highest foaming capacity, which was probably due to the average molecular weight being relatively low compared to that of other samples.

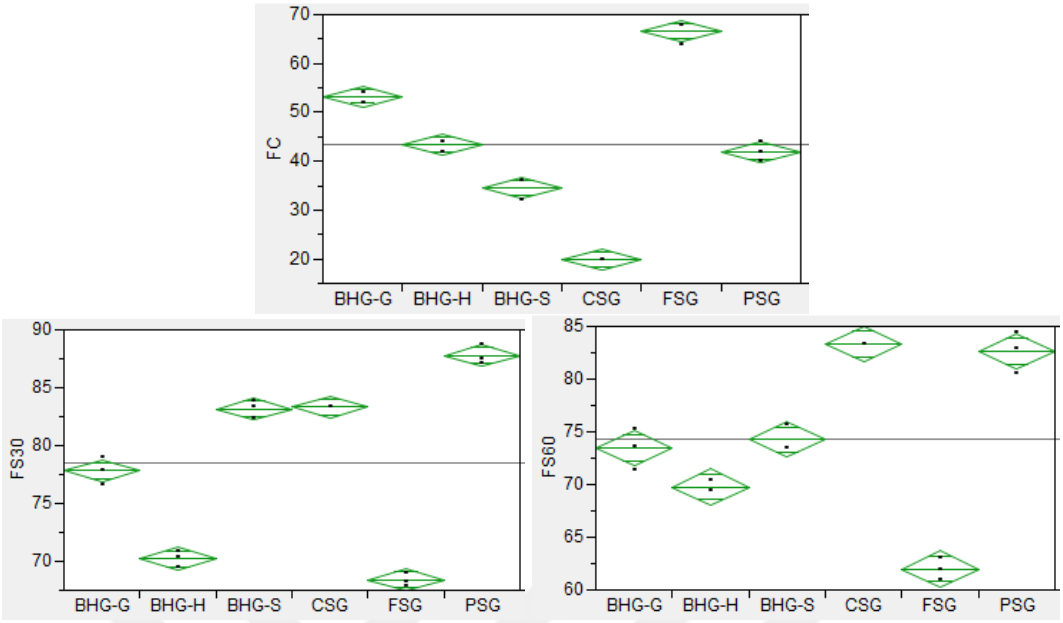


Figure 4.7. Foaming properties of gelatin samples.

Foaming capacity of chicken skin gelatin was low but foaming stability of this sample was among those of the highest, most probably because of active sites of the impurities playing significant roles in binding among the molecules. These strong bonds were probably responsible from remarkably strong foams of CSG compared to that of other samples. Foaming stability of CSG was similar and even higher compared to commercial gelatins while its foaming capacity was a bit lower. Differently from other commercial samples, FS30 and FS60 of CSG were identical and presented no indication of a labile foaming. However, the foaming capacity of other gelatin samples dropped with time as expected. This may be due to strong network structure formed between impurities, collagen fractions and other active molecules in the solution environment. As commercial gelatin is highly purified and deionized along with low mineral content as established by the quality standards of gelatin, such stability may not be achieved. Stronger bonds between these active molecules seems to be resulted in a stable foaming ability.

4.3.4. Emulsion activity and stability index

Emulsion characteristics of gelatin samples studied did not varied greatly although there were significant differences among the samples. Most notably, EAI and ESI of PSG were significantly lower than that of other samples, which may be due to average molecular size of the sample and the amount of active sites present. CSG, on the other hand, showed similar ESI values with all three bovine hide gelatins but significantly different from FSG and PSG. Considering the EAI values, CSG was significantly different from all other samples and higher in EAI, which was probably due to high level of impurities and their impact on binding among the collagen fractions leading to higher emulsion activity.

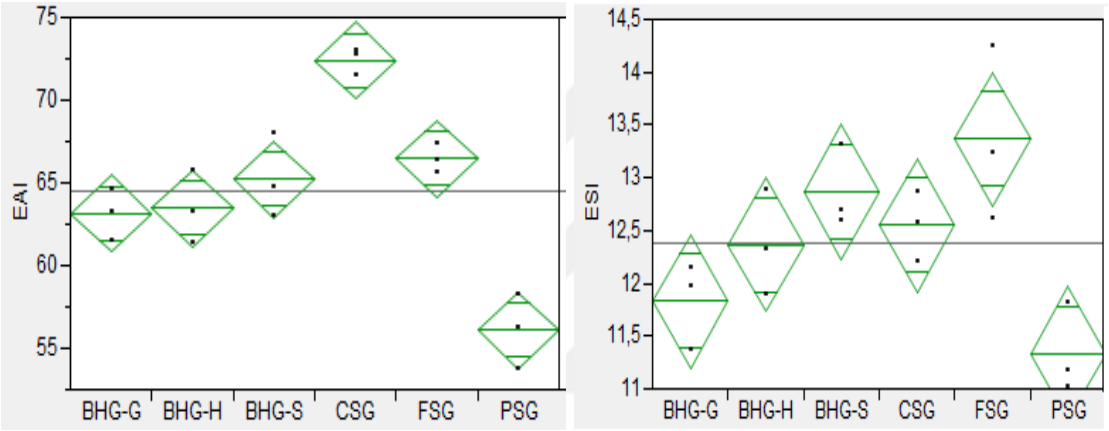


Figure 4.8. Emulsion activity and stability index of gelatin samples.

Potentially, active sites of impurities would play significant roles in binding between different fractions and molecules, therefore, emulsion activity of this highly complex sample was observed to be much higher compared to other commercial samples, which were at higher purity and prepared suitable according to the commercial standards. CSG, on the contrary, was containing high level of fat and minerals that could not be sufficiently removed from the resultant gelatin, which was probably the reason why CSG was low in transparency and high in emulsion activity. On the other hand, emulsion activity of bovine hide gelatins studied were mostly not significant from each other and significantly higher than PSG in case of EAI and EAI ($P<0.05$).

4.3.5. Texture profile analysis

Textural characteristics including hardness, adhesiveness, cohesiveness, springiness, gumminess and chewiness were given in Figure 4.9.

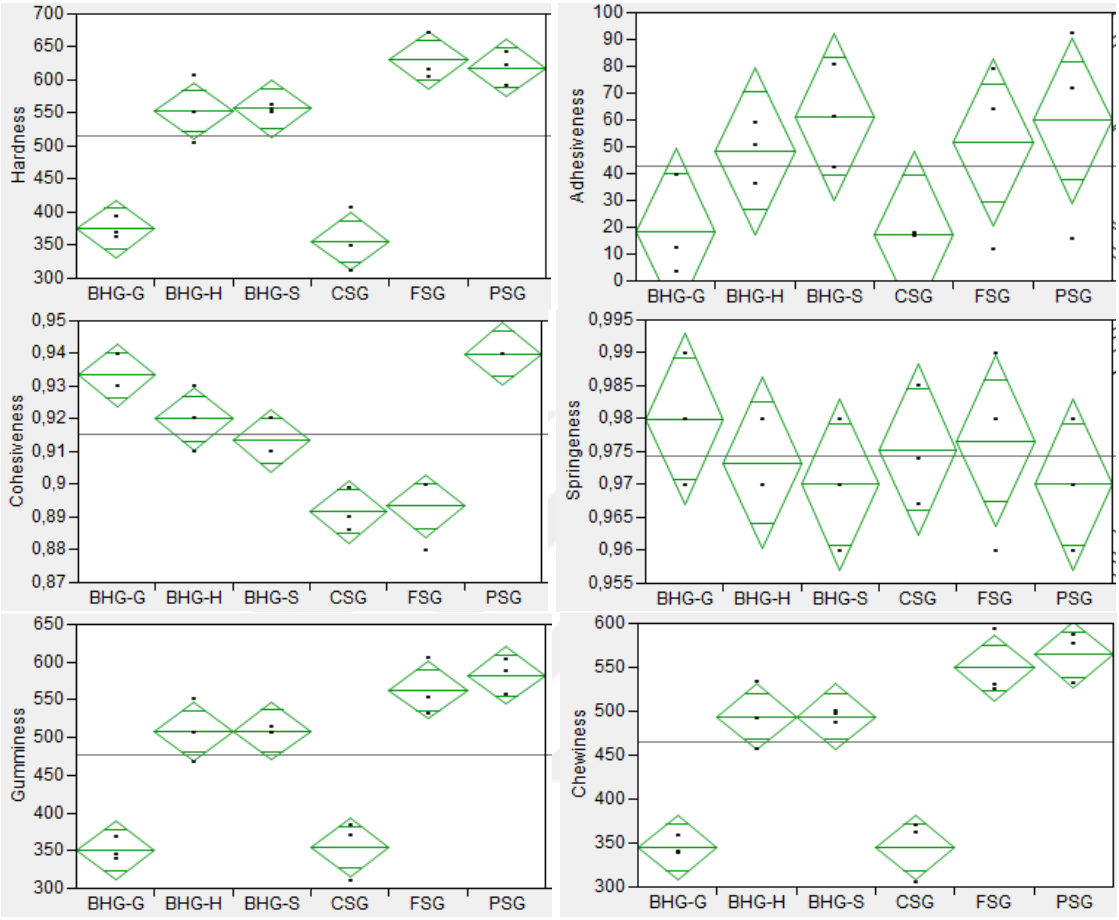


Figure 4.9. Texture profile parameters of gelatin samples.

There was no significant difference in terms of adhesiveness and springiness while all other textural parameters were significantly different among the samples ($P<0.05$). CSG showed similar hardness, gumminess and chewiness values with BHG-G while its cohesiveness was significantly lower ($P<0.05$). It may be speculated about potentially high quality of the gelatin extract from chicken skin as its gel strength and hardness, two of which were very similar characteristics, were almost identical with that of BHG-G. This was probably because of relatively high average molecular weight of CSG and high level of impurities, on the positive side considering their correspondence with the strong network structure.

5. CONCLUSIONS

Chicken skin, as opposed to its high fat and water content along with its relatively low level of protein content, can be considered as a significant resource for gelatin extraction. Although its protein content was just over 11% while its fat content was about 35%, after an effective separation of fat and water by degreasing and drying, respectively, protein content of the extracted gelatin was brought to the level of over 70%. This study clearly showed that chicken skin must be conveniently processed for removal of fat and water sufficiently and when it was done, its connective tissue protein, which was about 11%, can be a a significant resource for gelatin production.

Gelatin is an important hydrocolloid due to its ability of forming thermo reversible gels, unique thickening and water binding capacity, and its ease of dissolution (Haug and Draget, 2009). Poultry skin, feet, and bone, as alternative raw materials, has attracted tremendous attention from the researchers due to the intention of replacement of conventional raw materials (Gudmundsson, 2002; Schrieber and Garies, 2007; Karim and Bhat, 2009). On the other hand, preliminary studies showed the necessity of removing non protein residues or compounds to isolate the collagen, for an effective extraction and desired quality and functionality at the highest possible purity of the target molecules, the collagen fractions or gelatin.

Based on the results, pH of CSG was sdramatically lower compated to those of commercial samples, most propably due to acid washing step before extraction and ineffective neutralization in that step. High protonation of collagen fractions during acid washing may have lead to high pH values when this gelatin was dissolved in water. This pH value is obviously not acceptable for food grade gelatins and needs to be considered for further studies to get a reasonable pH value for the final product. All other gelatins gave pH values between 5 and 6 except BHG-H, of which was about 4.9.

Considering the transparency of the samples, in similar with pH, transparency of CSG was extremely high and its transparency was low due to impurities and the production under laboratory conditions, which lack unit processes of bioseparation including ultrafiltration, deodorization, deionization etc., which normally get involved in a commercial and industrial production of gelatin. As these bioseparation processes

lacked in our extraction procedure, high purity of collagen was not achieved and therefore, the resultant gelatin was dark in color and its transparency was high and unacceptable.

On the other hand, melting and gelling temperatures of CSG were acceptable and similar to those of commercial gelatin, indicating that chicken skin can offer an acceptable and reasonable gelatin, which is similar with other animal sources when its impurities was effectively removed and a proper series of unit operations was involved in its conversion into gelatin.

When it comes to probably the most significant characteristics of gelatin, gel strength and viscosity, which determine the quality and selling price of gelatin, CSG was not an outlier, showing slightly low viscosity compared to commercial gelatins while its gel strength was similar with that of BHG-G probably due to impurities again, which may play a supporting role in the network structure in gelatin gels. Nevertheless, the presence of high amount of collagen fractions was the reason of such reasonable level of gel strength.

Considering the functional characteristics of CSG, EAI was strikingly higher when compared to those of commercial samples as impurities may show superior binding properties to different active sites, therefore improving emulsion activity. ESI was similarly high in CSG but FSG was at the top when stability was concerned. WHC and FBC of CSG were dramatically low compared to other samples due to possible interfering roles of impurities in water holding and fat binding.

Based on the results obtained, an overall conclusion may be given as chicken skin must be carefully considered for gelatin production due to its high fat content, which readily and greatly interferes with the quality characteristics of the resultant gelatin. Therefore, fat content of chicken skin must be effectively removed before gelatin extraction. On the other hand, chicken skin, considering its high availability and its reasonably high amount of protein, must be utilized in gelatin extraction, providing an alternative and sustainable raw material to gelatin industry.

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EXTENDED TURKISH SUMMARY
(GENİŞLETİLMİŞ TÜRKÇE ÖZET)

Özet

Bu çalışmada, tavuk derisinden daha önce belirlenen ekstraksiyon koşullarına göre jelatin ekstraksiyonu gerçekleştirilmiştir. Elde edilen jelatin bazı kalite ve fonksiyonel özellikleri bakımından farklı kaynaklardan elde edilen ticari jelatinlerle karşılaştırılmıştır. Bu kapsamda; jel gücü, viskozite, jelleşme ve erime sıcaklığı, su tutma ve yağ bağlama kapasitesi, köpük ve emülsiyon özellikleri değerlendirilmiştir. Elde edilen sonuçlara göre, tavuk derisi jelatini genel olarak ticari jelatinlerle benzer kalite ve fonksiyonel özelliklere sahip olmakla birlikte, jelatinin yetersiz izolasyonu ve mevcut safsızlıkların fazla olması nedeniyle laboratuvar koşullarında elde edilen tavuk derisi jelatininde bazı parametreler daha düşük değerler göstermiştir. Ticari jelatinlerin çoğu 400 g değerinin üzerinde bir jel gücü gösterirken, tavuk derisi jelatininin jel gücü 300 g civarında gerçekleşmiştir. Benzer şekilde, ticari jelatinlere göre tavuk derisi jelatininin viskozitesi de düşük ancak erime ve jelleşme sıcaklığı değerlerinin benzer olduğu tespit edilmiştir. Sonuç olarak, kalite ve fonksiyonel özellikler bakımından olumsuz etkileşimlere neden olan safsızlıkların ayrılması için laboratuvar koşullarında jelatin ekstraksiyonunun daha fazla izolasyon ve saflaştırma aşamaları gerektirdiği düşünülmektedir. Diğer taraftan; yağ ve su içeriğinin etkili ve yeterli bir şekilde ayrılabilmesi durumunda tavuk derisinin yüksek kaliteli jelatin ekstraksiyonu için alternatif bir hammadde olabileceği gösterilmiştir.

Giriş

Bu çalışma “Tavuk Derisi Jelatininin Bazi Kalite Ve Fonksiyonel Özelliklerinin Belirlenmesi” adıyla tavuk derisinden elde edilen jelatinin bazı kalite ve fonksiyonel özelliklerinin belirlenmesi ve farklı kaynaklardan ticari jelatinlerle karşılaştırılması amacıyla gerçekleştirilmiştir.

Jelatin, hayvanların bağ dokusunda en yaygın bulunan protein olan kolajenin enzimatik veya termal yöntemlerle kısmen hidroliz edilmiş halidir. Gıda, ilaç ve kozmetik gibi pek çok sektörde jelleştirici, köpük oluşumunu düzenleyici, emülsiyon özelliklerini iyileştirici, kıvam artırıcı, topaklanmayı önleyici gibi pek çok amaçla kullanılan jelatin; en çok domuz derisi ve kemiğinden (>%60), bunun yanı sıra sığır derisi ve kemiğinden (>%30) ve az miktarda su ürünleri ile kanatlı işleme artıklarından üretilmektedir. Musevi ve Müslümanların domuz kaynaklı jelatini, Hinduların ise sığır kaynaklı jelatini tüketmemesi nedeniyle alternatif kaynaklardan jelatin üretimi son yollarda çok çalışılan bir konu haline gelmiştir.

Dünyada ve ülkemizde kanatlı üretimi gün geçtikçe artmakta ve ileri işlenmiş kanatlı ürünlerin toplamdaki payının artması ile işleme artıklarının da çeşitliliği ve miktarı artmıştır. Bu artıklar genellikle değerlendirilememekte ve çevre kirliliğine neden olmakta, bir kısmı ise düşük katma değeri olan ürünlere işlenmektedir. Söz konusu artıklar gerek yüksek ve değerli besin içeriği ile gerekse ucuz ve bol bulunabilme gibi avantajlar nedeniyle yüksek katma değerli ürünlere işlenerek doğal kaynakların daha verimli bir şekilde kullanılması, katma değer yaratılması, dışa bağımlılığın azaltılması, ihracat kapasitesinin artırılması, hammadde arzının ve çeşitliliğinin güvence altına alınması bakımından önem taşımaktadır.

Kanatlı işleme endüstrisi artıklarından biri de tavuk derisidir. Canlı ağırlığının yaklaşık %3'ü olan tavuk derisi %52 civarında su, %35 civarında yağ ve %11 civarında protein içermektedir. Söz konusu proteinin %90'dan fazlasının kolajen olduğu tahmin edilmektedir. Tavuk derisinde bulunan kolajenin uygun koşullarda işlenebilmesi ile jelatin üretiminde kullanılabilmesi muhtemeldir. Bu çalışma, tavuk derisinden jelatin elde edilmesi ve elde edilen jelatinin farklı kaynaklardan ticari jelatinlerle kalite ve fonksiyonel özellikleri bakımından karşılaştırılması amacıyla gerçekleştirilmiştir.

Materyal ve Yöntem

Tavuk derisinden jelatin ekstraksiyonu için en uygun ekstraksiyon koşulları daha önce yapılan bir çalışmada ana hatlarıyla belirlenmiştir. Söz konusu çalışmaya göre, tavuk derisinden 3 aşamalı bir prosesle jelatin ekstraksiyonu gerçekleştirilmiştir. Gözle görülür yağ ve et kalıntılarından temizlenen tavuk derisi önce 0.1 N NaOH, sonra 0.1 N

HCl ile oda sıcaklığında 3 saat boyunca yıkanıp saf suyla arındırılarak yağ ve istenmeyen bileşenlerinden temizlenmiş ve mevcut kolajen kısmen hidrolize edilerek jelatin ekstraksiyonu için hazır hale getirilmiştir. Ardından, 55°C'de 7 saat süreyle gerçekleştirilen jelatin ekstraksiyonu ile jelatince zengin ekstrakt elde edilmiştir. Bu çözelti plastik kaplar içinde 50°C'de su içeriği %10'un altına düşünceye ve jelatin filmler elde edilinceye dek yaklaşık 7-8 saat kurutulmuştur. Elde edilen tavuk derisi jelatini yurtiçi ve yurtdışından temin edilen ve farklı kaynaklardan elde edilmiş ticari jelatinlerle kalite ve fonksiyonel özellikler bakımından karşılaştırılmıştır.

Farklı kaynaklardan elde edilen ticari jelatinler bu çalışmada elde edilen tavuk derisi jelatini ile jel gücü, viskozite, erime ve jelleşme sıcaklığı, saydamlık ve pH gibi parametreleri içeren kalite özellikleri; su tutma kapasitesi, yağ bağlama kapasitesi, köpük oluşturma kapasitesi ve köpük stabilitesi, emülsiyon oluşturma kapasitesi ve emülsiyon stabilitesi gibi fonksiyonel özellikler ve son olarak tekstürel parametreler bakımından karşılaştırılmıştır.

Elde edilen jelatinin kimyasal kompozisyonunun ticari jelatinlere göre uygun olmayan bir yapıya sahip olmasına karşın, kalite ve fonksiyonel özelliklerinin karşılaştırılması amacıyla 5 farklı jelatin kullanılmıştır. Bu amaçla, balık derisi, domuz derisi ve 3 farklı sığır derisi jelatini sırasıyla Jiliding Marine Biotech (Jiangsu, ÇİN), Warenhandel (Neckarsulm, ALMANYA), M-Haditech (Bremen, ALMANYA), Halavet (Istanbul, TÜRKİYE) ve Seljel (Balıkesir, TÜRKİYE) adlı firmalardan temin edilmiştir.

Bulgular

Yukarıda anlatıldığı şekilde üretilen jelatinin kimyasal kompozisyonunun %71.7 protein, %9.1 su, %7.3 yağ ve %3.1 mineral olduğu tespit edilmiştir. Bu kimyasal kompozisyon dikkate alındığında, elde edilen jelatinin yağ ve mineral madde miktarının Kabul edilemeyecek kadar yüksek olduğu, diğer taraftan protein içeriğinin çok düşük olduğu belirlenmiştir. Bu durumun laboratuvar koşullarında yapılan yetersiz izolasyon ve ekstraksiyon işlemlerinden kaynakladığı; endüstriyel üretiminde yararlanılan membran ayırma teknikleri, koku giderme ve iyon değiştirme gibi işlemlerin yapılamaması nedeniyle olduğu düşünülmektedir.

Elde edilen sonuçlara göre, tavuk derisi jelatini genel olarak ticari jelatinlerle benzer kalite ve fonksiyonel özelliklere sahip olmakla birlikte, jelatinin yetersiz izolasyonu ve mevcut safsızlıkların fazla olması nedeniyle laboratuvar koşullarında elde edilen tavuk derisi jelatininde bazı parametreler daha düşük değerler göstermiştir. Ticari jelatinlerin çoğu 400 g değerinin üzerinde bir jel gücü gösterirken, tavuk derisi jelatininin jel gücü 300 g civarında gerçekleşmiştir. Benzer şekilde, ticari jelatinlere göre tavuk derisi jelatininin viskozitesi de düşük ancak erime ve jelleşme sıcaklığı değerlerinin benzer olduğu tespit edilmiştir. Tavuk derisi jelatini ile hazırlanan jellerin bariz bir şekilde düşük bir saydamlığa sahip olduğu ve yine benzer şekilde, pH değerinin çok düşük olduğu belirlenmiştir.

Sonuç ve Tartışma

Fonksiyonel özellikler göz önüne alındığında, tavuk derisi jelatinin t,car, jelatinlerle benzer fonksiyonel özellikler gösterdiği, hatta köpük ve emülsiyon özelliklerinin daha iyi olduğu görülmüştür. Ancak, bu durumun tavuk derisi jelatininde bulunan safsızlıklardan kaynakladığı düşünülmektedir. Sonuç olarak, kalite ve fonksiyonel özellikler bakımından olumsuz etkileşimlere neden olan safsızlıkların ayrılması için laboratuvar koşullarında jelatin ekstraksiyonu için farklı izolasyon ve saflaştırma aşamaları gerektirdiği düşünülmektedir. Diğer taraftan; yağ ve su içeriğinin etkili ve yeterli bir şekilde ayrılabilmesi durumunda tavuk derisinin yüksek kaliteli jelatin ekstraksiyonu için alternatif bir hammadde olabileceği gösterilmiştir.

CURRICULUM VITAE

Bana FATIH KARIM was born in 1986 in Suleymanie, Iraq. She completed elementary, high school and undergraduate studies in Iraq. She was accepted to Graduate School of Van Yüzüncü Yıl University in 2014 to pursue a M. Sc. degree in the Department of Food Engineering. She is married and mother of a wonderful kid.

T.C
VAN YÜZÜNCÜ YIL ÜNİVERSİTESİ
FEN BİLİMLERİ ENSTİTÜSÜ
LİSANSÜSTÜ TEZ ORİJİNALLİK RAPORU

Tarih: 15/05/2018

Tez Başlığı / Konusu:

Determination of Some Quality and Functional Characteristics of Gelatin Extracted from Chicken Skin

Yukarıda başlığı/konusu belirlenen tez çalışmamın Kapak sayfası, Giriş, Ana bölümler ve Sonuç bölümlerinden oluşan toplam 37 sayfalık kısmına ilişkin 15/05/2018 tarihinde Fen Bilimleri Enstitüsü tarafından iThenticate intihal tespit programından aşağıda belirtilen filtreleme uygulanarak alınmış olan orijinallik raporuna göre, tezimin benzerlik oranı %3 (üç)'tür.

Uygulanan filtreler aşağıda verilmiştir:

- Kabul ve onay sayfası hariç,
- Teşekkür hariç,
- İçindekiler hariç,
- Simge ve kısaltmalar hariç,
- Gereç ve yöntemler hariç,
- Kaynakça hariç,
- Alıntılar hariç,
- Tezden çıkan yayınlar hariç,
- 7 kelimeden daha az örtüşme içeren metin kısımları hariç (Limit match size to 7 words).

Van Yüzüncü Yıl Üniversitesi Lisansüstü Tez Orijinallik Raporu Alınması ve Kullanılmasına İlişkin Yönergeyi inceledim ve bu yönergede belirtilen azami benzerlik oranlarına göre tez çalışmamın herhangi bir intihal içermediğini; aksinin tespit edileceği muhtemel durumda doğabilecek her türlü hukuki sorumluluğu kabul ettiğimi ve yukarıda vermiş olduğum bilgilerin doğru olduğunu beyan ederim.

Gereğini bilgilerinize arz ederim.

Bana FATIH KARIM
15/05/2018

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