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Quality Comparison of Gelatins Manufactured from Raw and Scalded Pigskins

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생박 및 탕박 돈피에서 생산된 젤라틴 품질비교

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Abstract

In order to examine the appropriateness of types of pigskin as a raw material for gelatin production, comparison was made on the quality of gelatins made from raw and scalded pigskins. Raw and scalded pigskins were acidified in 1.7% HCl solution for 15-18 hr and then washed by tap water for 10 hr. After washing, pigskins were extracted at 60°C, 70°C and 80°C to produce gelatins. Gelatins from raw pigskins appeared to be better in gel strength than those from scalded ones at all extraction temperatures. Gelatin yield was higher with raw than with scalded pigskins. With the increase of extraction temperature, the decrease in gel strength and viscosity was resulted in. More colored gelatins were produced with increasing extraction temperature in both raw materials. Electrophoretic pattern of gelatins showed that higher molecular weight fractions decreased with the increase of extraction temperature and pigskin gelatin had more complicated molecular composition than that of type B gelatin (alkali-treated gelatin).

Introduction

The qualities of gelatins produced depend on such factors as species, breed, age and manner of feeding animals and the storage conditions to which raw materials have been exposed.[1] Furthermore, the physical and chemical properties of gelatin are functions of the source of collagen, the method of manufacture, conditions during extraction and concentration, thermal history, pH and chemical nature of impurities or additives.[2]

In order for collagen to be converted to gelatin, the intermolecular and intramolecular bonds which stabilize insoluble collagen rendering it insoluble must be broken, and the hydrogen bonds which stabilize the collagen helix must also be broken.[3] The simplest route from collagen to gelatin is the denaturation of soluble collagen which is newly formed and has no crosslinks. In this process, the triple helical structure of collagen is destroyed to produce one, two or three random chain gelatin molecules (collagen chains). This change takes place in mild conditions either by heating at neutrality to about 40°C[4] or by adding hydrogen bond breakers at room temperature or lower.[5] But under these mild conditions, no covalent linkages are destroyed. Thermal denaturation alone is insuffficient for the release of gelatin from more mature collagen because of the stabilizing effect of crosslinks. The release of a gelatin molecule from a fibrillar structure consisting of crosslinked protein chains must involve the breakage of at least one covalent bond.[6]

Gelatin is used in the food, pharmaceutical and photographic industries which take advantage of its unique properties such as reversible gel-to-sol transition of aqueous solution; viscosity of warm aqueous solution; capability to act as a protective colloid; water permeability; and insolubility in cold water but complete solubility in hot water. Worldwide over-all demand for gelatin has been growing steadily every year.[2]

In Korea, it is difficult to know exactly how much gelatin is manufactured every year. However, the amount of gelatin import has been increasing from $1,500,000 in 1979 to $2,390,000 in 1985. Therefore, in this study, with the consideration of making a better utilization of a livestock byproduct, the comparison was made on the quality of gelatins manufactured from raw and scalded

pigskins in order to examine the appropriateness of types of pigskin as a raw material.

Materials and Methods

Gelatin manufacturing

Raw and scalded pigskins were purchased from local processors. The commercial scalding in Korea is carried out at 60-70 C for 5-10 minutes. Pigskins were from Landrace barrows of about 90 kg of body weight. After pigskins were trimmed of visible fat (Table 1), they were acidified in 1.7% HCl solution for 15-18 hr and then washed by tap water for 10 hr. After washing, gelatin was manufactured according to the process illustrated in Lee and Kim.[7]

Analysis

Proximate analysis for raw materials and gelatins was carried out according to methods outlined in AOAC.[8] Gel strength, viscosity, pH, pI, color and clarity of gelatins were measured as described in Lee and Kim.[7]

Sodium dodecyl sulfate-polyacrylamide gel electophoresis: 0.5% gelatin sample solution was prepared containing 8M urea, 0.2% SDS and 0.2M phosphate buffer at pH 7.2. SDS-polyacrylamide slab gel electrophoresis was performed according to the procedure described by Cooper[9] using 10% gels.

Results and Discussion

Physical properties

Table 2 shows that gel strength and viscosity decreased with the increase of extraction temperature. When the extraction is done at near neutral pH, gel strength of the gelatin decreases with increasing temperature.[10] It might be because the increase of temperature resulted in the decrease of gelatin molecular weight due to the hydrolysis of peptide bonds. The properties of gelatin gel improve with increase in molecular weight from about 15,000 or one sixth the weight of an α-chain to about 90,000.[11] Solution viscosity of gelatins is directly related to M.W.[12]

Gelatins from raw pigskin appeared to have high value in gel strength than those from scalded one regardless of extraction temperature and in viscosity, only at 60 C (Table 2). The effect of an increase in pretreatment temperature is largely degradative and produces decrease in viscosity, rigidity and melting point.[13] In this study, however, the conditions at pretreatment stage were the same to different raw materials. Therefore, the effect of high temperature on gel strength seemed to be from the scalding.

Commercial gelatins are generally obtainable from 90 to 300 Bloom. Therefore, gelatin extracted at 80° C in this experiment is of little commercial value.

There appeared to be little effect of the type of raw material and extraction temperature on isoelectric point

Table 1. Chemical composition of raw and scalded pigskins (unit: %)

	Moisture	Protein	Fat	Ash
Raw pigskin	64.40±0.04	22.10±0.48	12.90±0.08	0.65±0.01
Scalded pigskin	54.50±0.13	26.95±0.02	17.80±0.10	0.45±0.04

Table 2. Properties of gelatins manufactured from raw and scalded pigskins at various extraction temperatures

Raw material	Raw pigskin			Scalded pigskin		
Extraction temperature (° C) / Item	60	70	80	60	70	80
Gel strength (Bloom)	272.4^{a}	190.5^{c}	47.0^{d}	242.9^{b}	73.6^{d}	12.0^{e}
Viscosity (centistoke)	8.56^{a}	4.78^{b}	2.55^{c}	6.51^{b}	4.71^{b}	2.68^{c}
pH	3.59^{b}	3.74^{b}	4.16^{a}	3.19^{c}	3.47^{bc}	3.71^{b}
pI	8.38^{ac}	8.73^{b}	7.95^{d}	8.25^{c}	8.51^{a}	7.94^{d}

abcde: Values with different letters in each row are significantly different ($P<0.05$)

(pI) of gelatins (Table 2). Typical pI of acid processed gelatins lies in the range of pH 7.5-9.4. The high pI of acid processed gelatins is due to resistance to hydrolysis of amide groups of glutamine and asparagine under acid conditions.[3] Various pH values are reported within the ranges of 3.8-5.0 for acid processed gelatins. The natural pH of gelatin is of importance only in little buffered systems when used in edible products.[14]

Color and Clarity

Color is usually not of too great concern. It is because color does not influence the properties of gelatin or reduce its usefulness. Table 3 illustrates that the increase in extraction temperature resulted in the increase in color intensity. Much colored gelatins resulted from the higher extraction temperature than from the lower temperature.[15] The color may be caused partly by a protein-carbohydrate browning reaction.[16] Color has been attributed also to the oxidation of amino acids, particularly tyrosine.[17] Therefore, the increasing effect of temperature on color intensity could be the increase of the browning reaction.

Clarity is related to the light scattered by insoluble impurities present as fine suspensions or emulsions which have become stabilized due to the protective action of gelatin itself.[17] The reason that gelatins extracted at 70°C were better in clarity than those at 60° C with both raw materials could not be found in this study. It has been shown that the presence of lipid and mucoproteins are main cause of turbidity in gelatin solution.[18]

Chemical composition and Yield

Proximate analysis of gelatins shows that chemical composition is in close agreement with that of commercial ones (Table 4). The moisture content of commercially prepared gelatins usually lies within the range of 9-14%.[6] Ash content is less than 2%. However, type A gelatin usually has less than 0.5% ash. The moisture and ash contents of gelatins together do not normally exceed 20% of the weight of solid.

Gelatin yield from pigskin is generally around 18-22%.[1] Table 4 shows that gelatin yield from raw pigskins was significantly higher than that from scalded ones. It might be because of the denaturation of collagen in the pigskin due to the scalding. Scalding the pig carcass is generally done at 60-70° C. Therefore, collagen in the scalded pigskin was presumably already denatured to some degree. Gelatin yields are reduced with increases in temperature prior to extraction.[1]

Electrophoresis

The bond breakages in collagen during gelatin manufacturing are determined on a probability basis under the effects of pH and temperature. This random characteristics of bond breakdown is the main cause of molecular heterogeneity in gelatin.[6] Molecular weight of gelatins varies from 50,000 to 200,000 or more.[19] There is an evidence that more than one polypeptide chain ranging in weight in the region of 50,000 to 80,000 are present per molecule.[20, 21] Figure 1 shows that between raw materials, there was not much difference in the composition of molecular species in gelatins (Column 1,2,3,4,5 and 6). However, higher molecular fraction in gelatin decreased with the increase of extraction temperature regardless of raw materials (Column 1&4 vs. 2&5 vs. 3&6).

Table 3. Clarity and color of gelatins manufactured from raw and scalded pigskins at various extraction temperatures

Raw material		Raw pigskin			Scalded pigskin		
Item \ Extraction temperature (°C)		60	70	80	60	70	80
Clarity (cm)		9.7ab	13.2ab	5.4b	9.4ab	16.0a	1.5b
Color	Dullness	0.10[a]	0.07[a]	0.13[a]	0[a]	0.03[a]	0.83[b]
	Orange	0.57[a]	0.77[a]	1.43[b]	0.40[a]	0.63[a]	2.13[b]
	Yellow	0.83[a]	0.67[a]	1.50[a]	0.53[a]	0.50[a]	4.47[b]

ab: Values with different letters in each row are significantly different ($P<0.05$)

According to Veis and Anesey,[22] electrophoresis of type B gelatin showed that δ polymer (tetramer of γ unit) appeared at the top, γ polymer (trimer of α chain) next, β polymer (dimer of α chain) third and then α chain last. Composition of molecular fraction in type B gelatin (Column A) was simpler than that of type A gelatin (Column 1,2,3,4,5 and 6). It has been shown that gelatins made from alkali-pretreated collagen (type B) contain little material of low molecular weight, as short fragments produced during pretreatment dissolve in the alkali liquor and little further breakdown occurs during extraction and drying. On the other hand, acid processed gelatins (type A) contain degraded materials.[23]

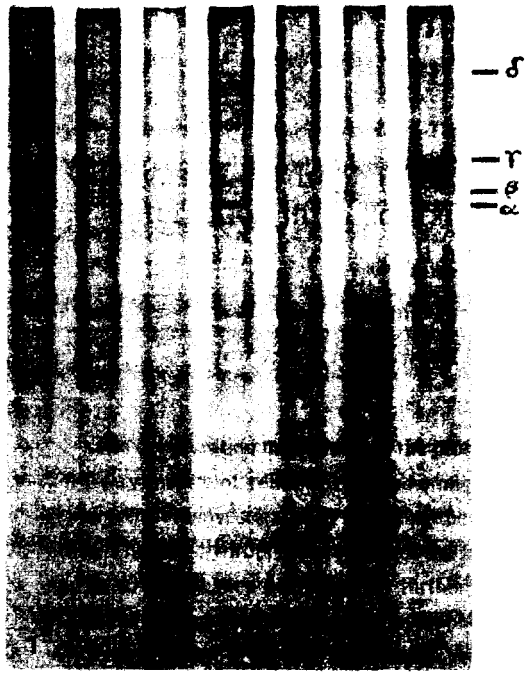

Fig. 1. SDS-PAGE of gelatins at pH 7.2: gelatins from raw pigskins extracted at 60° C(1), 70° C(2) and 80° C(3); gelatins from scalded pigskins extracted at 60° C(4), 70° C(5) and 80° C(6); commercial type B gelatin (A) from Rousselot S.A.Co., France. Designation of δ, γ, β and α was adopted from Veis and Anesey [22]

요 약

젤라틴 생산을 위한 원료로서 알맞은 돈피의 종류를 조사하기 위해 생박 및 탕박한 돈피를 이용하여 생산된 젤라틴의 품질을 비교하였다. 돈피를 1.7% HCl 용액에서 15-18시간동안 팽윤시킨 후 수도물에서 [illegible]간 동안 세척하였다. 세척된 돈피를 60℃, 70℃ 및 80℃에서 추출하여 젤라틴을 생산하였다. 생박돈피에서 생산된 젤라틴은 추출온도에 상관없이 젤 강도가 탕박돈피로 부터 생산된 것보다 우수하였다. 또한 수율도 생박돈피에서 높았다. 추출온도가 증가함에 따라 젤 강도와 점도는 감소하였고 색깔이 짙은 젤라틴이 생산되었다. 전기영동상으로 비교하여보면 추출온도가 증가할수록 고분자물질이 감소하였으며, 돈피젤라틴(type A)이 type B젤라틴에 비해 훨씬 복잡한 분자구조를 보여주었다.

Table 4. Chemical composition and yield of gelatins manufactured from raw and scalded pigskins at various extraction temperatures

(unit: %)

	Raw pigskin		Scalded pigskin	
	Extraction temperature (° C)		Extraction temperature (° C)	
	60	70	60	70
Moisture	7.48±0.35	8.37±0.21	7.68±0.67	5.95±0.17
Protein	90.03±0.22	89.16±0.23	89.20±0.64	90.74±0.16
Fat	1.16±0.24	1.09±0.08	1.96±0.09	1.89±0.17
Ash	0.78±0.03	0.92±0.08	0.52±0.08	0.68±0.04

	Extraction temperature(°C)				Extraction temperature(°C)			
	60	70	80	Total	60	70	80	Total
Yield	10.3[a]	6.9[b]	2.3[c]	19.5A	9.1[d]	4.8[e]	1.5[f]	15.4B

abc, def: Values with different letters in each raw material are significantly different ($P<0.05$)
AB: Significantly different ($P<0.05$)

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