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Broiler Feet Gelatine

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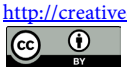

Abstract

The two waves period of the COVID-19 pandemic saw the use of hydro-alcoholic gel and the consumption of capsules containing improved traditional remedies. At one point, there was a stock-out and a price increase for these products. Furthermore, in the food industry, the catering industry adopts gelatin in its current practice. Pig gelatin dominates the international market. And for some religious practices, pork is forbidden and yet these people consume them without taking notice. The production of gelatin from broiler feet seems economically viable because broiler feet are considered slaughterhouse waste that is sold at very low prices. The poultry industry has seen an increase in broiler farming over the last twenty years. However, the latter has all the characteristics required for the production of gelatin. It will therefore comply with the standards of use described in the international codex oenological for gelatins. Physical and chemical analyses such as, ash content, moisture content, and pH measurements were done for the extracted gelatins. Sensible elements are checked with ED XRF spectroscopy. All the results were good and showed without any doubt that broiler gelatin is edible.

Keywords

Gelatin, Gel, Amino-Acids, Reticulation, Collagen, Broiler-Feet

1. Introduction

Many key periods marked gelatin. Its first concrete discovery was made by Denis Papin in 1681 with his study of the motive power of steam. The method consisted of boiling beef bone in a full digester. Then, the same method was improved by Jean Pierre Joseph Darcet in 1794. It consists of crushing the bones and extracting gelatin in an open vessel. In the history of medicine, it was during the period of the great world wars from 1914 to 1945 that doctors used gelatin as

a sponge to contain surgical hemorrhages. Since 1970, the cosmetics industry has been using gelatin for its protein aspect and scientists have been trying to understand the structure of collagens [1] [2]. Nowadays, 63% of the international produced gelatin goes to nutritional use. About 31% are intended for pharmaceutical use if only the last 6% are destined for technical uses. There are gelatins extracted from vegetal called, pectin. It is largely rare compared to porcine gelatin and other animals' gelatin [3]. The purpose of this study is to prove that, apart from, vegetal, bovine, fish and all other types of existing gelatin, broiler feet also can be a better raw material. This affirmation will be confirmed by the results of our tests and analysis.

Definition:

Collagen is the combination of two words, glue and gene, which means sticky substance. It is obtained by hydrating proteins that have the properties of transforming into glue or gelatin under the effect of heat.

Jelly means a highly viscous substance of animal or vegetable origin and is also the product of the partial hydrolysis of collagen contained in the skins, conjunctival tissue and bones of animals. The word is also confused by the property of very low temperature.

The word ***gelatin*** is a combination of the word "gelato" meaning ice and the suffix "ina" meaning amino acids, so gelatin means amino acid gel in Italian. In Latin, gelatin translates into *gelatus* which means firm or set.

Gelatin production:

The theory of how it was obtained is shown in Figure 1.

There are the fibrillar tissues contained in bones, animal skins, muscles and cartilage. After hydrolysis, structural proteins called collagens are obtained, and by a phenomenon of cross-linking, the gelatins bind together and form polymers [4].

In laboratory real case, this reaction happened in height (08) main steps, such as:

1) Raw material grinding;
2) First oil extraction;
3) Softening bath;
4) Acidity adjustment;
5) Collagen extraction;
6) Second oil extraction;
7) Dehydration;
5) Drying.

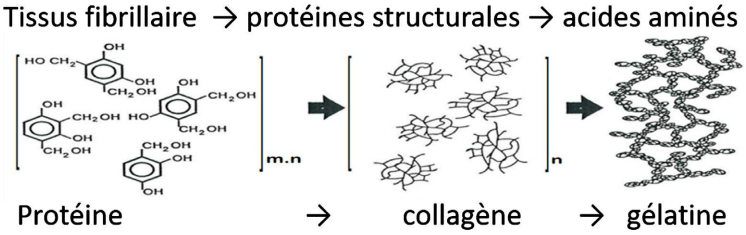

Figure 1. Protein to gelatin transformation [3].

During the first step, broiler feet are washed with hot water to avoid infections, then, gridded with manual meat mincer. There will be a second washing but the minced meat is poured in a hot water. This step marks the first oil extraction. Oils from the broiler will flow over the water and can be extracted easily by sieve. Now the meat will pass a softening bath. The aim of this step is to cut fibrillar tissues at the same time to soften bones.

At every step, pH was verified with electronic pH-meter. The probe detects the temperature at the same time as the pH. But we chose to measure at room temperature which is between 22˚C and 27˚C (Table 1).

- In all three trials, all samples became more acidic than the resulting broth.
- The one with the lower adjusted pH at the beginning always remains the most acidic and the one with the higher pH will approach neutrality.
- The broths become more acidic after cooking, this is due to the extraction of acids trapped in the gristle and especially the bones as the flesh and muscle can equalize its environment very quickly.
- Evaporation causes the acids to volatilize in about 45 minutes and then the acid residues make the gels more and more acidic. This is due to a surplus from the acid residues in the gels which cannot escape.

Dehydration step is made with rotavapor in a laboratory test. The temperature is set at 70˚C. Higher temperature might denaturalize completely the collagen. Lower temperature also will slower water extraction. The rest of solvent will help to produce the needed form of the final gelatin. The last step enhances the release of water imprisoned.

A quarter of the weight of gelatin is made up of essential amino acids of the order of 10 varieties. Of these, arginine and lysine are in the majority. Arginine is one of the 20 amino acids that make up the proteins in human cells. It plays a role in cell division, wound healing, the elimination of ammonia from the body, the proper functioning of the immune system and the secretion of certain growth hormones.

Apart from gelatin, there is also collagen peptides which is another product of collagen. It is called collagen hydrolysate, but not able to gel. Its molecular weight is lower compared to gelatin. Thus, it has lower degree of biological availability.

Physics and chemical analysis:

For weight distribution, several boiler feet are required. it must be carefully scraped with a stainless-steel blade. But the legs must also be weighed in advance.

Table 1. pH variation during the gelating preparation [5].

Seted pH	pH bath	pH before heating	pH aqueous gel	pH evap 2	pH evap 3	pH gel
Lot 4.5	4.8	4.5	4.2	4.5	4.3	4.1
Lot 4.9	4.7	4.9	4.5	4.7	4.4	4.6
Lot 5.6	4.8	5.6	5.1	4.9	4.7	4.9

The remains of the scales should be discarded because this could infect the collagen. In addition, it is these scales that will cause unpleasant odors. According to our tests, almost 29% of the total mass of the leg are bones. In several time, broiler feet (produced in Madagascar) weight between 46 g to 55 g. In total, there are 17 seventeen bones in a boiler leg (**Figure 2**).

The yield of our preparation is about 18% on average. We have noticed that more hydrolyzed extracted gelatins yield little. A mixture that is too acidic also reduces the yield. The most suitable medium for the extraction of gelatins is a pH around 5, which gave a yield of 19.59%.

To assess the ash content, we weighed about 5 g of sample into a porcelain container. Then put them in a muffle oven at 550˚C. The gelatins, swell quickly and tend to overflow from the container. So, we took them out of the oven and added ashless paper. And finally, we weighed the ashes. On average, the ash content is 0.415%, which is well below the maximum ash limit of <2%.

In order to measure the moisture content, weigh 5 g of gelatin in a clean, dry stainless-steel container. Put them in an oven at 105˚ C for 4 hours and cool them in a desiccator. On average, we obtained a moisture content of 10% after drying (**Figure 3**).

Figure 2. Broiler leg scraping [5].

Figure 3. Gelatin calcination [5].

Expiration date:

Gelatins are extremely hydrophile. Being dry is the most suitable condition to conserve it. The container must be isolated and not allow any air to enter it. Most of gelatin producer suggest plastic container. There are three different form of dry gelatin in the market. The most common format is laminate witch have a marked square channel to make distribution easy. The second form is pellet, a tinny cube which is extremely difficult to differentiate with yellow sugar cube. There is also a very fine power of gelatin, this one is whiter compare to the two other formats. Aqueous or diluted solution also exist but not in a big quantity in the market.

Aqueous solution of gelatin can not be use for long time. In a few days it produces a very bad smell. A certain dark green mold might be seen on the surface of the liquor solution. Viscosity also deceases day by day until water and a gel separation happened. If this disintegration continues, after two (02) day in a hermetic container, a bloc of gel start settles in its bottom. This gel is less gluer compared to the initial gelatin.

Viscosity comparison:

Viscosity is among the quality key for gelatin. A specific technical word called "*gelling capacity*" is used to define it and the unit is in "*bloom*" or "*degree bloom*" [6]. To be more acceptable, it is better to use viscosimeter. The scope is about to compare in one equipment the liquor solutions. As the porcine gelatin viscosity is not known yet, both porcine and broiler feet gelatin are studied. The equipment we use were the FANN viscometer model 35 A. It is a Newtonian rheology specifically for fluids. 350 ml of aqueous solution is poured in a cup. The gelatins are prepared simultaneously with the same condition in one magnetic agitator for around one hour of mixing. 8 different speeds are needed for the measurement reading (30 rpm, 60 rpm, 90 rpm, 100 rpm, 180 rpm, 200 rpm, 300 rpm and 600 rpm). A given table of how to attend those speeds is use for the manipulation. Then obtained results are finally used for viscosity calculation and converted in centipoise. Below are the results of our tests (**Table 2**).

The concentrations we give in the table were limited by the standard of the reading speeds. At less than 100 g of gelatin poured in one liter of water, 30 rpm Newtonian friction force is merely around zero so, the reading seems difficult. The higher concentration, contrarily, is due to the instability of the needle while the speed is 600 rpm. In addition, the higher value in the equipment screen is only 300 and as the gel start to glue, most of the time, there is an over range. The temperature must be the same for the measurement.

According to those results, porcine and broiler feet gelatins viscosity are almost

Table 2. Gelatins viscosity per concentrations [5].

DOSAGE [g/L]	100	150	200	250	300
Porcine [Cst]	11.86	18.24	23.21	27.56	56.27
Broiler feet [Cst]	12.54	18.84	22.94	26.86	55.03

the same. By taking a look at the following chart the tendency goes in one direction. Thus, it can be said that they might have the same or a very similar physical propriety (Figure 4).

Spectroscopy analysis:

Another criterion that describes whether a gelatin is consumable is based on quantitative studies of the mass concentrations of the elements it contains. For technological purposes, if there are too many elements that make the gelatins too wet, it will complicate photo paper production for example. Secondly, if the heavy matter content is too high, then the product is carcinogenic [7]. And finally, for the cooks, if there are undesirable elements, this will cause food poisoning.

The samples that can be measured with a spectroscope "spectro expos" are pellets. It uses energy dispersion X ray fluorescence technics. The materials, especially the pellet mould, must be washed thoroughly [8]. For more accurate measurements, the pellets must be crushed with this agate pestle and mortar. The granulometry is done with a 150 µm sieve. To form the pellets, 3 grams of sample flour must be poured in; then, the 20-ton mould must be pressed on this manual PRESS. Once the pellet has been demoulded, it must be secured in a plastic box and on a disposable towel. Do not touch the mould by hand but with a stainless-steel spatula. All the results are shown in Table 1.

During the measurements, operator can control energy impulsions that scroll in the screen. A given table of energy which is specified for the equipment can be used. At the end of the measurement, a curve chart is ready to be downloaded (Figure 5) (Table 3).

2. Conclusion

Preparation of gelatin from broiler feet is feasible and its yield is around 18%. Water evaporation requires strict temperature adjustment. Ash content of the obtained gelatin turns around 0.415% if the acceptable value is less than 2%. The

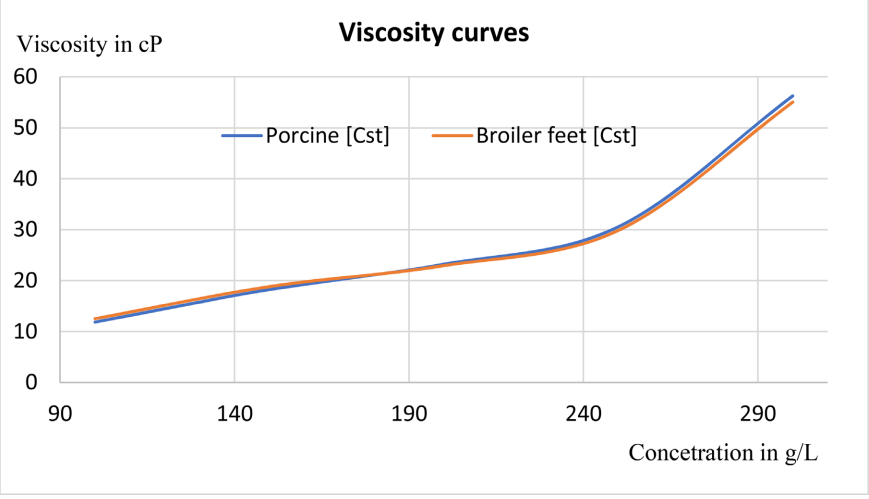

Figure 4. Gelatins solution viscosity [5].

Figure 5. Mould and gelatine tablet [5].

Table 3. Mass concentration per element of broiler gelatin [5].

Element	Concentration in mg/Kg	Limit value	Accuracy
Calcium (Ca)	62145.05	-	±317.52
Sodium (Na)	1291.55	-	±0.21
Magnesium (Mg)	2970.5	-	±81.72
Aluminium (Al)	616.10	-	±43.13
Phosphorus (P)	510.00	-	±30.60
Sulphur (S)	1528.00	-	±137.52
Chlorine (Cl)	201.25	-	±10.06
Potassium (K)	715.25	-	±68
Chromium (Cr)	8.42	10.00	±0.62
Manganese (Mn)	29.10	-	±1.74
Iron (Fe)	41.40	50.00	±5.09
Nickel (Ni)	5.50	-	±0.13
Copper (Cu)	2.85	30.00	±0.26
Zinc (Zn)	3.65	50.00	±0.25
Arsenic (As)	<0.50	1.00	±0.02
Selenium (Se)	<0.50	-	±0.02
Bromine (Br)	0.40	-	±0.02
Cadmium (Cd)	<0.25	0.50	±0.02
Rubidium (Rb)	1.75	-	±0.11
Mercury (Hg)	<0.10	0.15	±0.02

moisture content also respects the limit of its standard value estimated at 10%. Calcium is the most abundant element in bones, hence the values of its mass concentration is the heaviest. Our statistics show that 29% of broiler feet are bones. The seven sensible elements are under the limits proposed by the international codex oenological for gelatins [9]. Porcine gelatin and broiler feet gelatins are merely the same in terms of viscosity. According to the spectroscopy results, heavy metals, if present in the gelatin, are only traces. Then, broiler gelatins do not present any health risks.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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