

# Effect of Acidulants on some Properties of a Gelatin Dispersion

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## ABSTRACT

Three gelatin dispersions of 1.5% concentration were prepared. Two of the dispersions were acidified with fumaric and citric acids up to a concentration of 0.05 N. The third containing no acid, served as the control. The pH and the relative viscosity of the sols and the strength and liquifying time of the gels were determined for the three variables. The sol containing fumaric acid had the lowest pH, highest viscosity and its gel was the weakest as indicated by the greatest depth of penetration. The same gel also had the shortest liquifying time compared to the other two variables. The dispersion containing citric acid had a slightly higher pH and a lower relative viscosity than the one containing fumaric acid. The gel containing citric acid required more time to liquify and had a lower depth of penetration of the cone than the gel containing fumaric acid. The pH of the control sample was close to neutrality. This sol with no added acid had the lowest relative viscosity, and its gel had the least depth of penetration and required the longest time for liquification indicating a greater strength of the gel compared to those of the other two gels. From these observations it can be concluded that besides providing the desired tartness, acidulants also affect the other properties of a gelatin dispersion. Of the two acidulants tested in the present investigation fumaric acid appears to make the gelatin gel more weak compared to citric acid.

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## RESUMO

O objetivo principal do uso de um acidulante é prover a desejada acidez em um produto alimentar. Todavia, além disso, um acidulante pode também causar alterações em algumas propriedades do sistema alimentar. O presente estudo foi baseado na determinação do efeito de dois acidulantes, ácido cítrico (AC) e ácido fumárico (AF) numa concentração de 0,05 N, em dispersão de gelatina de concentração 1,5%. Uma amostra sem adição de ácido serviu como controle. O pH e a viscosidade relativa de

cada sol foi determinado, usando-se um potenciômetro e um viscosímetro de Ostwald, respectivamente. Uma quantidade padrão de sol foi colocada sob refrigeração para obter um gel. A profundidade de alcance de um penetrômetro cônico no gel e o tempo de liquefação do gel foi usado com índice de sua firmeza. O sol usado como controle tinha um pH próximo da neutralidade ( $6,9 \pm 0,2$ ) enquanto que os sóis contendo AC e AF eram mais ácidos, tendo pH  $3,9 \pm 0,2$  e  $3,3 \pm 0,1$  respectivamente. A viscosidade relativa do sol contendo AF foi maior ( $3,3 \pm 0,1$ ) do que aquela contendo AC ( $3,0 \pm 0,1$ ) a qual, por sua vez, foi maior que a do controle ( $2,7 \pm 0,3$ ). A profundidade de penetração do cone era  $2,88 \pm 0,03$ ;  $2,82 \pm 0$  e  $2,81 \pm 0,02$  cm para os géis contendo AF, AC e o controle, respectivamente. Seus tempos de liquefação, na mesma ordem, foram:  $40,3 \pm 2,5$ ;  $43,0 \pm 3,0$  e  $54,7 \pm 4,6$  minutos. Estes dados seguem uma tendência definida nas propriedades das dispersões de gelatina. A dispersão contendo AF, que possuía o menor pH e seu gel era mais fraco, como indicado pela maior profundidade de penetração do cone e o menor tempo de liquefação. A dispersão contendo AC teve valores intermediários àqueles da dispersão contendo AF e o controle. Pelas observações feitas na presente investigação foi possível concluir que AF produz uma dispersão de gelatina mais ácida, e o seu gel mais fraco que do AC, quando usado como um acidulante.

## INTRODUCTION

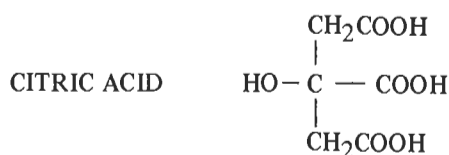
Gelatin<sup>1</sup> is a derived protein prepared from collagenous material found in animal tissues. The principal sources of edible gelatin are demineralized bones and skins of animals (Idson and Braswell, 1957). Pure dry gelatin is a tasteless odorless solid which is yellow to amber in color.

Gelatin contains 18 amino acids in amounts varying with the source. The amino acids found in large quantity are, glycine 29%, proline 16%, hydroxyproline 14%, glutamic acid 11%, arginine 9% and alanine 9% on a dry weight basis (FAO, 1970). The lack of tryptophan in gelatin makes it an incomplete protein. The basic molecular chain of gelatin polypeptide is twisted into a left handed helix, and three of these helices are coiled to form a right handed super helix which is held together probably by hydrogen bonds.

In the preparation of gels, the gelatin is allowed to swell in a small amount of cold water. The cross links between the chains prevent solution of gelatin in the cold water, but when the temperature is increased, the intermolecular bonds are broken and the gelatin disperses. The mechanism for the formation of a gel from a gelatin dispersion is not quite well known. However, several suggestions have been made by different researchers (Boedtger and Doty, 1954; Olsen, 1932).

A given sample of gelatin may have variation in the peptide chains, the molecular weight, in the number of acidic and basic groups in the side chains and in the amino acid sequence. These factors as well as the concentration of gelatin, its pH, temperature, method of cooling and the presence of other reagents influence the interaction between gelatin and solvent, and affect the properties such as viscosity and gelling power of gelatin sols and gels, respectively (Paul, 1972).

The objective of the presente study was to determine the affect of citric and fumaric acids on the above mentioned properties of a gelatin dispersion in water.



Fumaric acid is one of the most acidic of the solid acids, both in the amount of H<sup>+</sup> it provides in aqueous solution and in the apparent acidic taste it imparts. However, its application is limited to some extent by its relatively low solubility in water. Citric acid is widely used in food industry and has the advantage of being readily soluble in water (Gardner, 1966).

## MATERIAL AND METHODS

Gelatin (1) was first hydrated in cold distilled water for 10-15 minutes. Then boiling water was added to obtain a concentration of 1.5% gelatin. This gelatin sol was divided into three lots; one served as the control and to each of the other two was added citric or fumaric acid to a concentration of 0.05 N.

An aliquot of 160 ml of each sol was transferred to a labeled container (170 ml capacity), and 18 ml was poured into a test tube. These were allowed to stand at room temperature for 30 min after which they were covered with plastic film and refrigerated for approximately 24 hr. The remainder of each sol was used for the measurement of pH and viscosity.

The pH was measured using a pH meter<sup>2</sup> with a glass electrode. Relative viscosities of the gelatin sols were determined by measuring the time of flow of equal volumes of water and that of the sols using an Ostwald's viscometer immersed in a water bath maintained at 28°C. The strength of the gels were determined using a penetrometer<sup>3</sup> provided with a cone type probe. The measuring system for the instrument estimated the distance travelled (mm) by the probe when subjected to a given force for a period of 15 seconds (Jacobson, 1972). The liquifying time which is related to the liquifying temperature was determined by inverting the tubes of gel on a flat tray maintained under a relatively constant temperature ( $29 \pm 2^\circ\text{C}$ ). The time required for each gel to liquify completely, was noted.

The experiment was repeated three times and a minimum of three replications were done for each test. The differences in the data among the variables were tested for significance using the student's test (Snedecor and Cochran, 1967).

## RESULTS AND DISCUSSION

The mean and standard deviation of the pH and relative viscosity of the sols and the depth of penetration of the probe into the gels and the liquifying time of the gels are graphically presented in Figure 1.

Although the acidity of the two test samples was adjusted to the same normality (0.05 N), the pH of the sol containing citric acid was significantly ( $P < 0.01$ ) higher ( $3.90 \pm 0.06$ ) than that containing fumaric acid ( $3.31 \pm 0.17$ ). The pH of 0.05 N aqueous solutions of citric and fumaric acids was 2.86 and 2.73, respectively. Even though the normality of a solution of acid indicates the amount of total available H<sup>+</sup>, it is more applicable to measure the pH which expresses the activity of H<sup>+</sup>

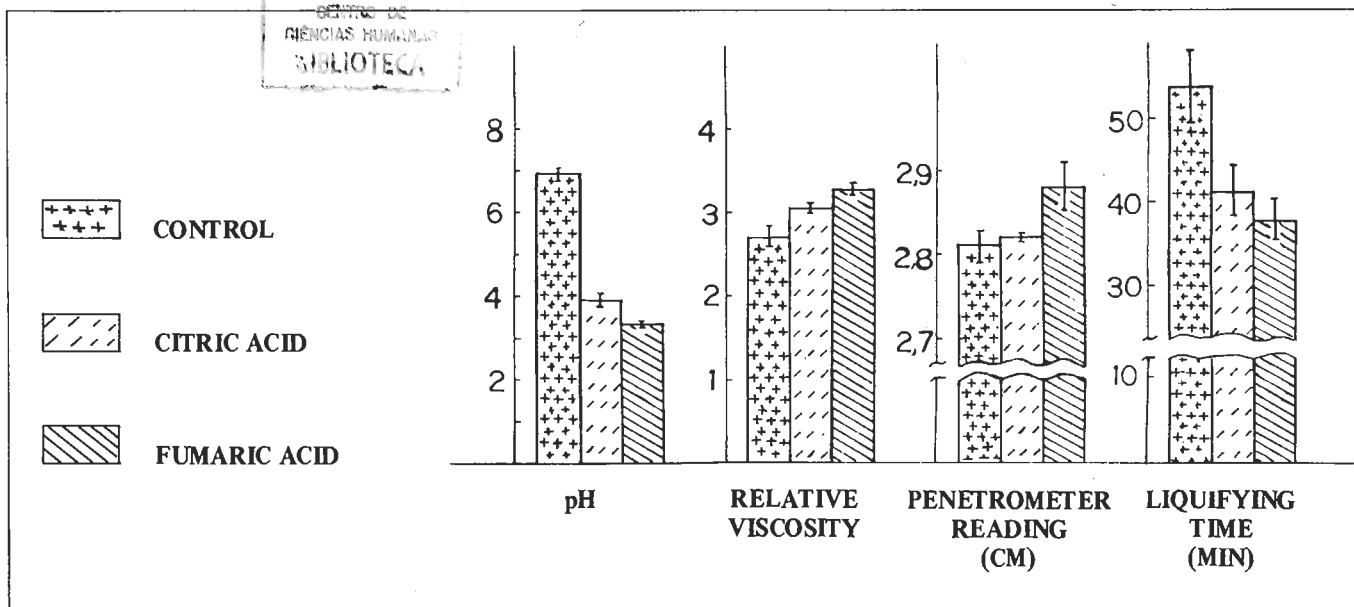


Figure 1 - The effect of acids on some properties of gelatin dispersions.

or the effective  $H^+$  concentration (Jacobs, 1958). The change in the  $H^+$  concentration is said to be the basis for the behavioral changes in the sols and gels of gelatin (Loeb and Kunitz, 1923). The pH of the control sol was significantly greater than that of either of the test samples ( $P < 0.01$ ).

Comparison of the relative viscosities of the sols calculated by dividing the flow time of the sols by that of an equal volume of water (6 replications) indicated that there was a significant difference among the three samples tested ( $P < 0.05$ ). The isoelectric point (IEP) of gelatin varies depending on the method of pretreatment of collagen in the preparation of gelatin. The acid treated gelatin has an alkaline IEP (pH around 8.9), while the IEP of alkali treated gelatin is around pH 5 (Paul, 1972). The gelatin molecules are fairly compact at the IEP, but as the pH moves toward either extremity, the molecules become more elongated and thereby contribute to an increase in the viscosity. The observations made in the present investigation with regard to pH and viscosity (Figure 1) agree well with the above reasoning.

The meand depth of penetration of the cone into the gel containing fumaric acid was significantly greater compared to that containing citric acid and the control ( $P < 0.05$ ). However, there was no significant difference in the depth of penetration in the latter two gels. The gel containing fumaric acid appears to be weaker than the other two. This property of the gel

containing fumaric acid is also obvious from its shorter liquifying time (Figure 1) compared to that containing citric acid and that of the control. The control gel required a significantly longer time ( $P < 0.05$ ) to liquify compared to the test samples.

The variation in the properties of the gelatin dispersions as observed in the present study followed a definite trend. The sol containing fumaric acid had the lowest pH and the highest relative viscosity when compared to the one containing citric acid and the control. The gel strength was lower in that containing fumaric acid, as indicated by the greater depth of penetration of the cone and the same gel had a shorter liquifying time compared to that containing citric acid which was intermediate in the above properties when compared to the control and the other test sample.

#### CONCLUSIONS

The results of the tests performed in this study seem to be related to the pH of the gelatin dispersion. The viscosity of sol increased with the decrease in the pH. The liquifying time was lower in the sample with the lower pH and there was greater depth of penetration of the cone into the gel which had the lower pH. Although the primary objective of using acidulants in foods is to provide the desired tartness, it is important to determine their effects on other properties of food products.

- (1) Sexton, packed by John Sexton and Co., Sexton Park, Indianapolis, Indiana, USA.
- (2) Beckman pH meter, Model G, Beckman Instruments Inc., Fullerton, California, USA.
- (3) Precision Universal Penetrometer, Precision Scientific Co., Chicago, Illinois, USA.

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