広島女学院大学論集　第46集
*Bulletin of Hiroshima Jogakuin University* **46**:133－138, Dec. 1996


# On the Gel Formation in Tomato Jelly

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(1996年10月9日　受理)

## Abstract

Tomatoes can be preserved as juice, puree, pastes, ketchup and many other products. At present tomatoes can be grown in greenhouses and thus, can be purchased throughout the year. During the summer when the tomatoes are in season a great quantity is harvested. Therefore, they are a very convenient material for laboratory use.

In Europe and in America it is known that jams can be made from tomatoes, however, reports on jelly are few. The present report deals with making jelly using tomatoes which were in season. In comparison with other fruits, it was found that the pH and sugar needed adjustment in order to obtain an acceptable jelly.

## Introduction

Goldthwaite's[1] definition of an ideal jelly is as follows: "Ideal fruit jelly is a beautifully colored, transparent, palatable product obtained by so treating fruit juice that the resulting mass will quiver, not flow, when removed from its mold; a product with texture so tender that it cuts easily with a spoon, yet so firm that the angles so produced retain their shape; a clear product that is neither syrupy, gummy, sticky nor tough; neither is it brittle and yet it will break, and does so with a distinct, beautiful cleavage which leaves sparkling characteristic faces. This is that delicious, appetizing substance, a good fruit jelly."

It is already known that jellies can be made from fruits such as nawashiro berries[2], sour apples, sour plums, sour blackberries and citrus fruits and others[3)4)5)6)], however, studies using vegetables as ingredients are few[7] and with tomato, only recipes on jam or other ingredients added to form gel are published[8)9)10)]. Therefore, in the present paper, studies were made to find whether the use of tomato will give a good gel to make jelly as defined by Goldthwaite[1]. The reason for the selection of tomato is that it can be purchased throughout the year, which makes it possible to use this product for jelly making in laboratory class when other fruits are unavailable.

## Jelly Making

Tomatoes (*Lycopersicon esculantum* momotaro) were used as material. Three stages of maturation were selected, that is, underripe, ripe, overripe tomatoes were used in this study. They were first cooked for 20 minutes and then the mass was transferred to a muslin bag. The juice was then tested for its pectin and acid content. In order to obtain gel formation, tomatoes must have the following proportion (Table 1).

**Table 1.** Proportion of Pectin, Sugar and Acid to Obtain Gel Formation

| Ingredients | Content |
|---|---|
| pectin | 0.6%−1.2% |
| sugar | 60%−70% |
| organic acid | 0.5%−1.0% |
| pH | 2.8−3.4 |

## Pectin

To find whether pectin is sufficient or not in tomatoes, an alcohol test was made by adding 95 per cent ethyl alcohol to an equal volume of juice. The result is shown in Fig. 1. It is clear that a sufficient amount of pectin is precipitated in ripe tomatoes as with other fruits such as sour apples and citrus fruits, which indicates the presence of pectin. Another method of estimating the pectin content of fruit juice is to study its viscosity. Baker[11] has developed a simple viscosity pipet, called the Jelmeter, for estimating the pectin content of fruit juice. This device is described in detail by Charley[11] . In the case of ripe tomatoes it was found from the use of the Jelmeter that the juice must contain approximately 70% sugar. However, in overripe tomatoes, pectin content was insufficient to form a gel although the bright red color appeared acceptable. On the other hand, the underripe tomatoes produced a dull orange color. (Fig. 2).

## Acid

A fruit juice ideal for jelly making must contain acid. To find whether tomatoes need adjustment or not, tests were made.

The pH of three stages of ripening was measured by using a Corning pH meter and the results are shown in Table 2.

**Table 2.** Changes in pH and Sugar Content during Ripening of Tomato

| Stage of Ripeness | Underripe | Ripe | Overripe |
|---|---|---|---|
| pH | 3.9 | 4.3 | 4.7 |
| sugar | 3.3% | 5.0% | 6.0% |

From the above chart it is clear that in the case of all three stages of ripening an adjustment of the pH is necessary, otherwise, a poor product will result (Fig. 3). The gel will not hold its shape.

**Table 3.** Amounts of Acid Required to Adjust Tomato Juice to pH 3.24–3.26

| Acid | Volume (ml) |
|---|---|
| 1N tartaric acid | 35 |
| 1N citric acid | 39 |
| lemon juice | 145 |

to prepare 500 ml of juice

Juice from ripe tomatoes were selected in the adjustment of pH. Three kinds of acids, 1N tartartic acid, 1N citric acid and lemon juice, were tested to lower the pH (Table 3). The individual use of these acids resulted in undesirable flavors. Therefore, proportions of acids were blended to find whether the flavor could be improved (Table 4).

From the results of the taste panel two volumes of lemon juice to one volume citric acid gave a mild and acceptable flavor. Thus, this proportion was used for making jelly.

**Table 4.** Proportion of Acids to Adjust pH

| Lemon juice | Citric acid (2N) | Volume (ml) |
|---|---|---|
| 1 | 1 | 37.5 |
| 1 | 2 | 26.0 |
| 2 | 1 | 45.0 |
| 1 | 0 | 145.0 |
| 0 | 1 | 19.5 |

to prepare 500 ml of juice

## Sugar

The amount of sugar used in a jelly depends on the amount and quality of the pectin within the juice. As mentioned before, viscosity test was made and it was fount that approximately 70% sugar should be added.

**Table 5.** Effect of Sugar on the Yield of Jelly

| Sugar (g) | Jelly Volume (ml) |
|---|---|
| 400 | 380 |
| 350 | 460 |
| 300 | 345 |
| 250 | 315 |
| 200 | 270 |

500 ml juice was used in each case

From Table 5, it is clear that the most volume and the least sag was obtained by using 350 g. of sugar for each 500 ml. juice. (Fig. 4, 5).

## Conclusion

Tomatoes are one of the most versatile vegetable—they can be eaten raw, stewed, baked, fried and broiled and in preservation can be dried, frozen, pickled, made into jams, jellies, juice, paste, puree and ketchup. Due to these uses it is one of the most convenient vegetable for laboratory class.

From various tests a recipe for tomato jelly is as follows:

| | |
|---|---|
| Tomato | 1 kg. (makes 500 ml. juice) |
| Lemon juice | 30 ml. |
| Citric acid | 0.63 g. (2N 1.5 ml.) |
| Sugar | 350 g. |

After adding the sugar, the procedure is the same as that for other fruit jellies. That is, the ingredients are boiled rapidly without stirring until the temperature is 5° C above the boiling of water as determined for the thermometer used[2)4)11)] .

## References


1) Goldthwaite, N. E., 1925. Principles of making fruit-jellies, Colorado Agr. Expt. Sta. Bull. 298, Fort Collins.
2) Hirahara, S. and M. Hayashi, 1970. "On Making of Jelly with Nawashiro ichigo *Rubus Parvifolius* L." Hiroshima Jogakuin College **20**, 75-79.
3) Macleod, A. L. and E. H. Nason, 1937. Chemistry and Cookery, McGraw-Hill Book Co. 568 pp.
4) Vail, G. E., R. M. Griswold, M. M. Justin and L. O. Rust, 1967. Houghton Mifflin C. Boston 693 pp.
5) Lowe, B. 1957. Experimental Cookery. John Wiley & Sons, N. Y. 573 pp.
6) Griswold, R. M., 1963. The Experimental Study of Food, Houghton Mifflin C. Boston 577 pp.
7) Grigson, J. 1995. Jane Grigson's Vegetable Books, Michael Joseph Ltd., London translated by Kasuga, T. and Hirano, K. 532 pp.
8) Constable, G., 1983. The Good Cook Preserving, Time Life Book Inc. 176 pp.
9) Bocuse, P., 1984. "Bocuse dans votre cuisine". Flammarion, translated by Tokuo Takahashi, 345 pp.
10) Tomatoes: 1995. 365 healthy recipes for year-round enjoyment, by the editors of Garden Way Publishing Book. Vermont 284 pp.
11) Charley, H., 1970. Food Science, The Ronald Press Company, New York. 520 pp.

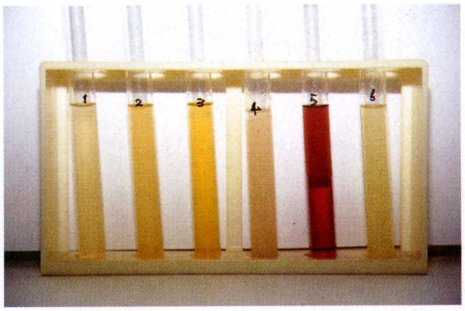

**Fig. 1.** Gel formation in juice of 1. underripe tomato 2. ripe tomato 3. overripe tomato 4. sour apple 5. grape 6. kiwi.

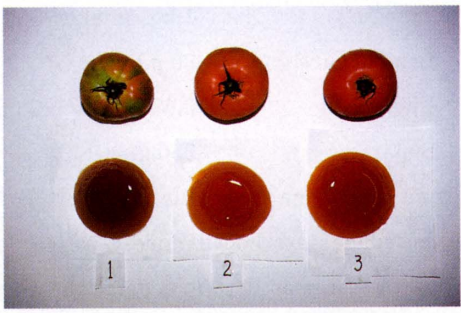


**Fig. 4–a.** Color of jelly resulting from the use of various stages of tomato. 1. underripe 2. ripe 3. overripe.

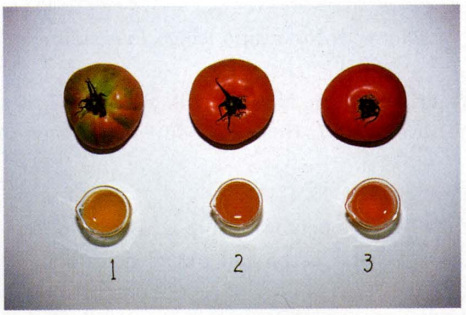


**Fig. 2.** Various stages of tomato. 1. underripe 2. ripe 3. overripe, and corresponding juice extracts.

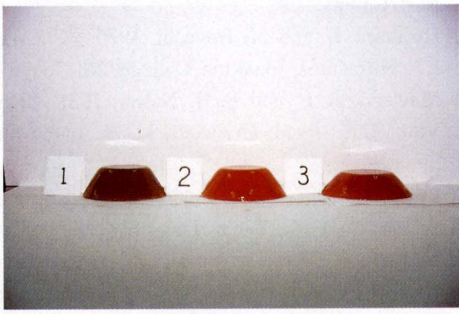


**Fig. 4–b.** Side view of the three kinds of jellies corresponding to 4–a. 1. underripe 2. ripe 3. overripe.

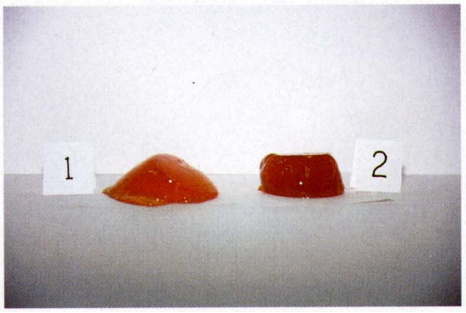


**Fig. 3.** Effect of acid added to the juice. 1. pH not adjusted. 2. pH adjusted to 3.24–3.26.


**Fig. 5.** Yield of jelly from various proportions of sugar. 1. 250 g. 2. 350 g. 3. 400 g.