Solution to the copper pots and jam challenge

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Our congratulations!

Solution

In the copper pots and jam challenge [1], it was discussed that jams become firmer when cooked in copper pots. Indeed they do, but why?

In the first approximation, fruits are plant tissues made of cells [2] which are surrounded by phospholipid/protein cell membranes and are linked by cell walls made of celluloses, hemicelluloses and pectins [3]. It has long been known (Henri Braconnot, 1825) that pectins are responsible for jam making. Indeed, celluloses and hemicelluloses change little during thermal processing, but pectins are modified significantly.

Pectins makes up approximately 1 % of fresh fruits [4, 5] and are composed of a linear D-galacturonic acid polymer backbone occasionally interrupted by branches made of various other saccharides [6]. This simplistic description makes it easy to understand that when divalent ions such as Ca^{2+} are not present in a high quantity, reduction of the pH is useful for jam making as it will (among other

phenomena) result in protonation of the carboxylic groups of the galacturonic acid residues, which in turn reduces the electric repulsion, allowing hydrophobic forces to promote the association of pectin chains at the less hydrophilic parts of the molecules. This is why cooks use lemon juice (although some fruits naturally have a very low pH—I remember measuring the pH of raspberries as low as 2—but they are still edible because of the high sugar content).

It has to be added that a considerable proportion of the galacturonic acid residues of the backbone are esterified by methyl and acetyl groups [7]. The esterification is important for gelification [8]: depending on the extent of esterification, the number of carboxylic groups that can loose their proton changes and so does the texture of jam. One can consider that pectin gels form by association of the hydrophobic methyl groups. However, gels from pectins with a low degree of esterification form with the help of divalent or polyvalent cations—such as calcium [9, 10] or copper (Fig. 1)!

Copper is not so safe, but calcium is said to be good for our health. The next time you make a jam, why not dissolve a clean eggshell with lemon juice and use the resulting liquid to improve the firmness of your jams [11]!

Fig. 1 In systems made of pectins and a large quantity of divalent calcium (or copper) ions, pectin molecules can bind through electrostatic forces between electronegative oxygen atoms and ions

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References

1. This H (2013) *Anal Bioanal Chem* 405:15–16
2. McNeil M, Darvill AG, Fry SC, Albersheim P (1984) *Ann Rev Biochem* 53:625–663
3. Roland JC (1980) In: Costes, Monties (eds) *Les polymères végétaux*
4. Massiot P, Thibault JF, Rouau X (1989) *Cahier scientifique et technique* 9:727–732
5. Aspinall GO (1980) In: Preiss J (ed) *The biochemistry of plants*. Academic, New York, pp 457–500
6. Voragen AGJ, Pilnik W, Thibault JF, Axelos MAV, Renard C (1995) In: Stephen A (ed) *Food polysaccharides and their applications*. Dekker, New York, pp 287–340
7. Pérez S, Mazeau K (2000) Hervé du Penhoat C. *Plant Physiol Biochem* 38:37–55
8. Renard C, Crépeau MJ, Thibault JF (1995) *Carbohydr Res* 275:155–165
9. Braccini I, Grasso R, Pérez S (1999) *Carbohydr Res* 317:119–130
10. Ralet MC, Crépeau MJ, Buchholt HC, Thibault JF (2003) *Biochem Eng J* 16:191–201
11. This H (2008) *Actual Chim* 315(1):9–11