

## 爆発するかりんとう

# Cooking karinto, analogical link to magmatic vesiculation and explosion

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Karinto is one of the typical traditional sweets, which is classified as a puffed confectionery. When we examine the cross section of karinto we can recognize amazing resemblance to the texture of vesiculated pyroclastic materials. This gives us an idea that the formation mechanism of karinto seems collateral to that of pumice and scoria in volcanic process and it would help deep understanding of magmatic vesiculation process. This is the starting point of our research on karinto.

Here we report experimental investigation on the formation of karinto, cooking process. Particularly we focus on the sound generation during the cooking to characterize vesiculation process. The basic material of the starting dough is flour, baking soda, sugar and water. Baking soda and water determine volatility of the sample. Heating induces vaporization of water and thermal decomposition of baking soda, which result in volume-expansion and create a peculiar vesiculated texture. To see the control of this we tested following 4 sets of the composition;

Sample A: flour 50g, baking soda 2g, sugar 10g, water 25g

Sample B: flour 50g, baking soda 0g, sugar 0g, water 25g

Sample C: flour 50g, baking soda 2g, sugar 0g, water 25g

Sample E: flour 50g, baking soda 0g, sugar 0g, water 30g

Sample A is based on the standard recipe of karinto. Sample C and E seem interesting to see the effect of volatile components.

In the cooking experiment we put the dough of 50mm in length x 10mm in width x 6mm in thickness into hot oil at 180-170C. Soon after start of deep frying familiar cooking sound becomes audible. We recorded this and took movie by high speed camera to inspect size and location of bubbles which emanate from the dough. Common to all the composition the sound changes systematically; in the first several minutes continuous sound with flat spectrum to 25KHz emanates while after this high frequency component gradually decreases and prominent peaks in the spectrum appear in several hundreds Hz, which sound as "chant d'Oiseau". Associated with this transition size of bubbles which appear on the surface of dough changes from broad distribution to homogeneous. Also the vesiculation points become localized. All these observations are consistently interpreted that after 4-5minutes steady paths of the gas emission from the inside have been set up. The talented experienced patissier could discriminate the difference of the sound to inspect maturity.

Only in the case of Sample E destructive explosions were observed at about 2 minutes from the start. During heating two competing processes are working inside the dough: solidification which proceeds from the outside and gas formation. Both are driven by higher temperature. When the solidification advances ahead hard shell is formed to impede escape of gas, which results in accumulation of high vapour pressure inside. This is the cause of the explosion. The standard recipe smartly avoids this route by arranging combination of the ingredients but in our experiments we seek the condition for explosion.

In the presentation we report progressive evolution of the spectrum of cooking sound with textural evolution in relation with magmatic process.

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