What Conditions Are Needed to Pop

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Abstract

We had an interest in “Why do kernels pop?”, so we researched what is in common between popped beans and grains. We found that beans and grains which popped, all had a hard skin. We made an artificial skin for soybeans which didn’t pop with caramel sauce to make sure that hard skin is necessary to pop. We succeeded in making soybeans popped with artificial skin so we concluded that hard skin is necessary to pop. We also found that glutinous rice pops without hard skin so we suspected that starch (amylose, amylopectin) has a relation to popping because glutinous rice or other grains basically have a lot of starch.

We did experience in terms of the ratio of amylose and amylopectin which each beans or grains has. We learned that ones which have much amylose popped well as oil’s temperature get higher, so the ratio of amylose and amylopectin and oil’s temperature also have a relation to popping.

1. Purpose

According to reference 1, kernels pop at constant temperature and pressure, but little is known about how kernels pop, so this study was performed to find conditions necessary for popping through finding beans and grains which really pop and what kind of circumstances each beans and grains has have an impact on popping.

2. Experiment 1

2-1. Method

We deep-fried a total of 30 corn kernels at three different temperature in an IH cooker. For each different temperature we deep-fried ten kernels each. The temperatures were 80, 150, and 180. Then, we deep-fried them for 2 minutes and checked whether or not they popped.

2.2. Result

Kernels did not pop at 80℃, but they popped at 150℃ and 180℃. And kernels deep-fried at 150℃ are larger than those popped at 180℃.

2.3 Discussion

We found that there are minimal and optimal temperatures to pop corn kernels.

3. Experiment 2

3-1. Method

We deep-fried a total of 120 corn kernels at six different temperatures in an IH cooker. For each different temperature we deep-fried twenty kernels each. The temperatures were 150, 160, 170, 180, 190, and 200. Then we took a sample of three popped kernels from each different temperature and using the 3D scanner from Keyence, we determined the surface area of the popped corn.

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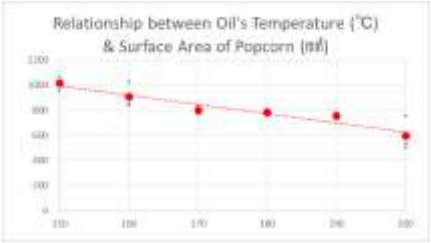

3-2. Result

The surface area of popcorn deep-fried at 150℃ was the largest and popcorn deep-fired at 200℃ was the smallest.

3-3. Discussion

In this experiment, 150℃ is the best temperature for corn kernels to pop. However, 150 ℃ is the lower temperature we determined. Therefore, it is presumed that the best temperature is 150℃ or under.

4. Experiment 3

4-1. Method

We chose beans and grains. There were corn kernels, brown rice, glutinous rice, barley, dattansoba, soybean, and azuki bean. We set the temperature of the IH cooker at 150℃ and deep-fried 10 beans and grains each. Then, we deep-fried the kernels for 2 minutes and checked whether or not they popped.

4-2. Result

Kernels, brown rice, glutinous rice, barley, dattansoba were able to pop, but soybean and azuki bean were not able to pop. And when we deep-fried them, we saw gas come out from the inside of the soybean and azuki bean.

4-3. Discussion

Corn kernels, brown rice, glutinous rice, barley are monocotyledon, and dattansoba, soybean and azuki bean are dicotyledons. Dicotyledon means that the cotyledons are spilt, so gas comes out from the inside, so they do not reach enough pressure needed for popping. We thought that soybean and azuki beans did not pop for this reason, so hard skin is necessary for popping. And, dattansoba is a dicotyledon, but it is wrapped skin which can resist high pressure from the inside, so we thought it could pop.

kernel	brown rice	glutinous rice	barely	dattan-soba	soybean	azuki bean
○	○	○	○	○	×	×

Monocotyledons　　Dicotyledons

brown rice　glutinous rice　barley　dattan-soba

5. Experiment 4

5-1. Method

We coated beans with edible caramel made from sugar and water at the ratio of 1:1. We checked whether they popped or not when heated in a microwave oven at 600W. The microwave prevents caramel from melting before the pressure inside of the beans rose enough. We also used corn kernels to compare.

5-2. Result

Kernels and soybeans popped, but azuki beans did not. Also, soybeans burned as can be seen in figure 11.

kernel	soybean	azuki bean
○	○	×

5-3. Discussion

We found that hard skin is necessary for popping. However, azukibeans did not pop even when they are covered with caramel sauce like hard skin. Therefore, we suspected that not only the external features of the kernels but also the make up of them affect popping.

6. Experiment 5

6-1. Method

The next chart shows composition and popping percentage of each seeds.

	kernel	brown rice	glutinous rice	barley	dattan-soba	soybean	azuki bean
Popping(%)	97.5	46.7	63.4	75.0	60.0	0	0
Carbohydrate(%)	59.6	71.1	77.2	76.2	61.0	29.5	58.7
Lipid(%)	22.8	2.7	1.2	2.1	2.8	19.7	2.2
Protein(%)	10.2	10.1	6.4	7.0	10.8	33.8	20.3

6-2. Result

65% of glutinous rice popped even though they do not have hard husk. Compared with other seeds, glutinous rice has more carbohydrates and the starch is 100% amylopectin, so we considered that the ratio of amylose and amylopectin affects popping.

7. Experiment 6

7-1. Method

We checked whether Indica rice (high amylose rice) popped or not when deep fried at 170℃ to 200℃ at 10℃ intervals.The maximum amount of time we deep fried th rice grains was for two minutes.

7-2. Hypothesis

We have already found that glutinous rice which is low in amylose can pop although it does not have a hard husk. Based on this, seeds which have a high amount of amylose like Indica rice will not pop easily.

7-3. Result

As the deep frying temperature rose, more Indica rice popped.

7-4. Discussion

The kinds of starch have nothing to do with popping, but more Indica rice popped as heating temperature went up, so it is considered that popping temperatures changes depending on the kind of starch. Also amylose have more hydrogen bond than amylopectin, so seeds with much amylose need more heat when popping coated beans with eatable caramel, which was made from sugar and water at the ratio of 1:1. We checked whether they popped or not. When heated in a microwave oven at 600W. The microwave prevents caramel from melting before the pressure inside beans rises enough we also use kernels to compare.

8. Future assignment

We found that hard skin is necessary for popping, but the necessity of starch and hydrogen bond is unclear. We need to do another experiment with cornstarch and rice powder to learn the relationship between amylose and amylopectin.

9. References

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10. Key words

Popcorn Starch Monocotyledon Dicotyledon Hard skin Popping