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STUDY ON THE PROPERTIES OF MODIFIED STARCHES AND THEIR USE IN THE PRODUCTION OF DUMPLINGS

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Through the systematic study of modified starch, four kinds of modified starch which probably can improve the physical and chemical properties of crystal dumpling skin were screened out, namely potato acetate starch, potato hydroxypropyl starch, octenyl succinate starch sodium, acetate cassava starch. They were added to the raw material powder of crystal dumpling skin according to different proportions. The physical indexes of the crystal dumpling (skin) were determined and analyzed. Then the most suitable modified starch, potato acetate starch.

Crystal dumpling is one of the representative food of crystal skin pasta. It is widely loved by consumers for its crystal clear appearance and smooth elastic and tough taste. At the same time, in the process of making crystal dumpling skin, it is easy to crack due to water loss, and it is not easy to roll into shape and the skin is easy to crack. In this paper, the effects of the characteristics and processing conditions of four different modified starch on the characteristics of crystal dumpling skin were studied.

Four kinds of modified starches that are expected to improve the quality of crystal dumpling skins were selected. Through the determination of the physical indicators of the above four modified starches, and then explore the feasibility of applying them to crystal dumpling skins to improve their quality. Studies have found that the light transmittance of the four modified starches is higher than that of the original crystal dumpling mixed starch, which verifies the feasibility of applying these four modified starches to the crystal dumpling skin to improve its transparency and other characteristics. At the same time, it provides a certain reference value for related research on improving the characteristics of crystal dumpling skin.

Studies have shown that the use of modified starches, which have specific properties, can influence the quality of the shell for dumplings, increase its strength and transparency, which will give new products high consumer properties.

Key words: *modified starch, organoleptic properties, structure, water-holding capacity, crystal dumpling skin, gelatinization.*

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Introduction. At present, quick-frozen dumplings are developing rapidly in the quick-frozen food industry, accounting for 30% of the frozen food industry (Zhang Wenye, 2005). However, quick-frozen dumplings will have problems such as cracking of dumpling skins and muddy soup during processing, transportation or eating, especially for crystal dumplings made of whole starch, due to the poor water holding capacity of the epidermis, it is very easy to lose water during the production process and it is easy to freeze and crack during quick freezing at -50°C. Therefore, it is very important to find ways to improve its quality characteristics. Modified starch is a starch derivative obtained by processing physical and chemical methods on the basis of the original starch (Zhang Yanping, 2007). At present, a large number of studies have shown that the application of modified starch in dumplings can improve its transparency, reduce the rate of freeze cracking and cooking loss, etc.

In view of the fact that there are more researches on the application of modified starch in quick-frozen dumplings made of flour (Liu Wenjuan, 2015; Yi Tuo, 2019; J. Colivet, 2017; Zhang Sen, 2016), and there are relatively few researches on modified starch in quick-frozen crystal dumplings made of whole starch. The main research contents of this topic are: taking the commercially available crystal dumpling powder as the blank group and combining previous studies, four modified starches that are expected to improve the quality of crystal dumpling skins were selected: potato acetate starch, potato hydroxypropyl starch, octenyl succinate starch sodium, acetate cassava starch, by studying the physical properties of these starches, and then

exploring the feasibility of applying it to crystal dumpling skins to improve its quality.

Materials and methods. The following types of starch were used for the study:

– wheat starch and corn starch (OS) – Shandong Fanpu Food Co., Ltd;

– potato acetate starch (MS 1) – Bolian Food Biotechnology Co., Ltd.;

– potato hydroxypropyl starch (MS 2) – Jinzun Food Ingredients Mall;

– octenyl succinate starch sodium (MS 3) – Shengda Food Business Department;

– acetate cassava starch (MS 4) – Henan Wanbang Industrial Co., Ltd.

The properties of modified starches were determined using the following methods: RVA-Starch Master 2, Rapid viscosity analyzer, Shanghai Ruifen Company; L-550 Desktop low-speed large-capacity centrifuge, Hunan Xiangyi Company; PH-070A Electric heating constant temperature blast drying oven Shanghai Yiheng Company; Electronic balance (0.0001g) Shanghai Qingke Tianmei Company; 722 Visible spectrophotometer Shanghai Youke Company; XW-80A vortex mixer Haimen Qilin Bell Company; HH-S2 digital display constant temperature water bath Jiangsu Jinyi Company.

Determination of swelling degree and solubility of modified starch

Weigh 0,5g (dry basis, denoted as w0) of modified starch in a dry and clean centrifuge tube, weigh w1, add 20mL of distilled water, mix with a vortex mixer for 30s, respectively at 45, 55, 65, 75, 85, 95℃ keep in water bath for 30min, cool to room temperature, centrifuge at 5000r/min for 15min, pour off the supernatant, weigh w2, calculate the swelling power and solubility of modified starch according to formula (1) and (2) respectively (Lawal OS, Adebowale KO, Ogunsanwo BM, et al., 2005, 35:71-79); Take 5 mL of the supernatant and place it in a drying dish at 105°C and dry it to a constant weight to obtain the quality w3 of the water-soluble starch.

$$Swelling\,Power = \frac{w_2 - w_1}{Dry\,weight\,of\,raw\,starch} * 100\% \quad (1)$$

$$Solubility = \frac{4w_3}{Dry\,weight\,of\,raw\,starch} * 100\% \quad (2)$$

Determination of transparency of modified starch paste

Add 1% (dry basis) modified starch suspension into a 20mL test tube, and then place it in a 95℃ water bath to heat for 30 min, mix with a vortex mixer every 5min for 30s, wait to cool to room temperature, and measure the starch paste at a wavelength of 650 nm light transmittance, distilled water is used as a blank (Onofre F.O.,WANG Y.J., 2010), the light transmittance reflects the transparency of starch paste.

Determination of gelatinization characteristics of modified starch

The gelatinization characteristic value of starch is determined according to the method standard specified by the American Association of Cereal Chemists (AACC). Accurately weigh a certain amount of starch, the starch mass fraction is 6.0% (w/w, db), add it to an aluminum box containing 25g of distilled water, stir evenly with a rotating paddle, and place it in an RVA-rapid viscosity analyzer for measurement.

Data processing and analysis

The statistical analysis of the data obtained in the experiment uses SPSS 24 software for statistical analysis of the data, and Origin Pro 9.1 software for drawing processing. All data are given in Mean ± SD, and the ANOVA method is used for the significance test. $p<0.05$ means statistically significant difference.

Results and discussion.

Modified starch Swelling power and Solubility

Swelling power reflects the water absorption capacity of starch during cooking, and reflects the characteristics of amylose (Gomand S.V., Lamberts L., Visser R.G.F.,et al., 2010). Amylose inhibits the expansion of starch the influence of temperature on the swelling power of mixed starch and modified starch is shown in Figure 1. Within 45℃~95℃, the overall trend is that the swelling power of modified starch increases with increasing temperature. This is because as the temperature increases, more water molecules enter the amorphous area of the starch granule. When the temperature reaches its gelatinization temperature, the swollen amorphous area accelerates the destruction of the starch crystallization area, which in turn leads to an increase in starch swelling (Lawal Q.S., 2009; Choi S.G, Kerr W.L., 2004).

(OS-wheat starch: corn starch=3:1 mixed starch; MS1-potato acetate starch; MS2 – potato hydroxypropyl starch; MS3 – octenyl succinate starch sodium; MS4- cassava acetate starch).

Solubility reflects the magnitude of the interaction force between starch and water, and has a greater impact on the processing characteristics of starch. The dissolution of starch is mainly due to the escape of amylose from the swollen granules (Lee J.S.,Kumar R.N.,Rozman H.D.,et al, 2005,91:203-211). The solubility of the original mixed starch and the modified starch is shown in Figure 2. The solubility of the modified starch increases with the increase of temperature, and the solubility increases rapidly from 65℃. This is because the starch is heated to absorb water and gelatinize rapidly, and high-energy water and heat destroys the internal hydrogen bonds of starch molecules, and part of the amylose gradually dissolves in water when heated, so the solubility of starch increases significantly (Meng Xiangyan, 2008; Berton B.,Scher J.,Villieras F., et al. 2002; Policegoudra R.S., Aradhya S.M.,2008).

Transparency of modified starch paste

The transparency of modified starch paste is reflected by light transmittance, which reflects the mutual solubility of starch and water (Du Shuangkui, Zhou Liqing, Yu Xiuzhu et al., 2010; Du Xianfeng, Xu Shiying, Wang Zhang, 2002). The light transmittance of the original mixed starch and modified starch is shown in above Figure 3. The light transmittance of the four modified starches is higher than that of the original mixed starch OS, and the light transmittance of MS2 is the highest, followed by the light transmittance of MS3 and

MS1, MS4 has the lowest light transmittance but still higher than OS. This proves that the idea of applying it to crystal dumpling skins to improve its transparency is feasible.

Gelatinization properties of modified starch

The gelatinization properties of starch are an important indicator reflecting the quality of starch, which affects the appearance, texture and mouthfeel of noodle products. The gelatinization characteristics of these starches were measured by RVA. RVA measures the process from the beginning of water absorption and swelling of starch granules to the destruction of the granular structure under the action of shear force and the leaching of starch molecules (Cozzolino D, Roumeliotis S, Eglinton J.,2013).

The gelatinization characteristic values of different raw starches are shown in Table 1.

For the gelatinization temperature: the gelatinization temperature of the mixed powder with modified starch is higher than that of the blank group, and the gelatinization temperature except for the MS4-15% powder which are increase with the addition of modified starch; for peak viscosity and pow viscosity: the peak viscosity and low viscosity of the mixed powder with modified starch are lower than the blank group, and increase with the increase of the content of modified starch; Final viscosity: The final viscosity of the mixed powder with modified starch added is lower than that of the blank group. For attenuation value and retrogradation value: the attenuation value and retrogradation value of the mixed powder with modified starch added are lower than the blank group, and except for the fourth modified starch, the attenuation value and retrogradation value of other blended powders decreased with the increase of modified starch content. This may be due to the preferential water swelling of modified starch, which limits the water available for wheat starch, hinders the expansion of wheat starch, and leads to the decline of the gelatinization parameters (such as peak viscosity, attenuation value and retrogradation value, etc.) of the blended starch (Lin Ying, Xin Zhiping, 2011(05): 91-95).

Conclusion. Based on previous studies, it is determined that the four modified starches selected are: Potato acetate starch, Potato hydroxypropyl starch, Octenyl succinate starch sodium, Acetate cassava starch. The properties are compared and analyzed by measuring their physical indicators. The difference between them is found: Compared with the original mixed powder, the light transmittance of the four modified starches is higher than that of the original mixed starch. Among them, potato hydroxypropyl starch has the highest transparency; among the four modified starches, acetate cassava starch has the lowest light transmittance but is still higher than the transparency of the original mixed starch. The research results of gelatinization characteristics show that: modified starch has a great influence on the gelatinization characteristics of the original mixture: the gelatinization temperature is increased, and the remaining gelatinization parameters (peak viscosity, low viscosity, final viscosity, attenuation value, and retrogradation value) are reduced. This verifies the feasibility of the idea of applying these four modified starches to crystal dumpling skins, and at the same time provides a certain reference for related research on improving the characteristics of crystal dumpling skins.

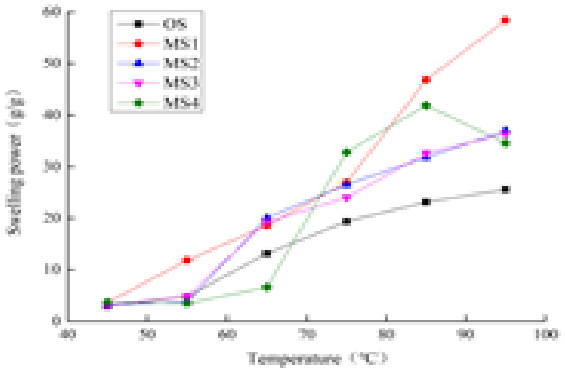

Figure 1. The effect of temperature on the swelling power of native starch and modified starch

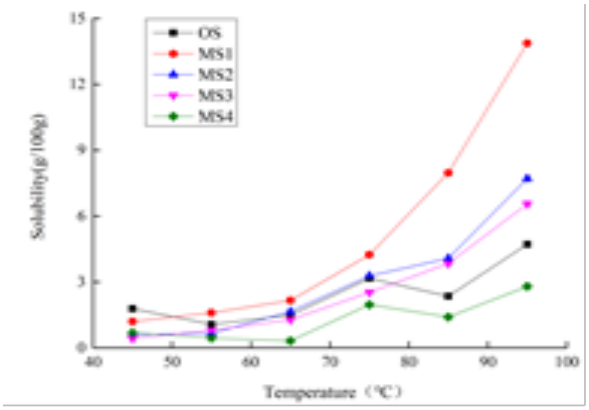

Figure 2. The effect of temperature on the solubility of native starch and modified starch

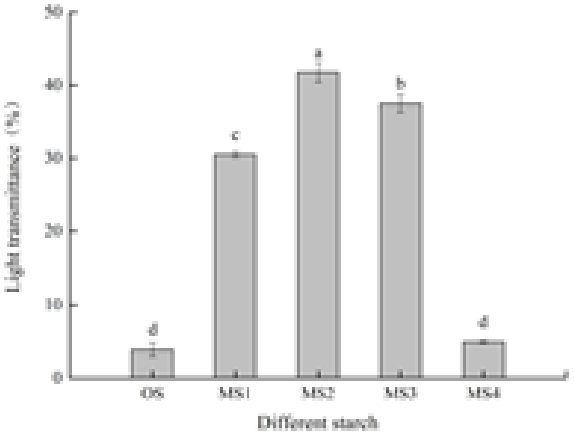

Figure 3. Light transmittance of different native starches and modified starches.

Table 1

Effects of types and addition amount of modified starch on Gelatinization characteristics of original mixed powder

Sample	Gelatinization temperature/cp	Peak viscosity/cp	Low viscosity/ cp	Final viscosity/cp	Attenuation value/cp	Regeneration value/cp
0	59.2±0.1	2248.3±0.6	1746.3±0.2	3179.0±0.9	562.0±0.1	1446.0±0.4
MS1-5%	77.7±0.3	1447.3±0.0	1054.0±0.7	2149.7±0.0	393.3±0.9	1095.7±0.4
MS1-10%	72.1±0.2	1478.3±0.5	1140.3±0.8	2141.3±0.3	338.0±0.5	1001.0±0.1
MS1-15%	71.2±0.7	1493.3±0.0	1157.3±0.1	2142.0±0.5	336.0±0.9	984.7±0.5
0	59.2±0.1	2248.3±0.6	1746.3±0.2	3179.0±0.9	562.0±0.1	1446.0±0.4
MS2-5%	86.0±0.7	1364.0±0.8	971.0±0.8	1996.0±0.7	393.0±0.7	1025.0±1.0
MS2-10%	79.8±0.1	1381.0±0.8	1033.7±0.4	1955.3±0.5	347.3±0.0	921.7±0.5
MS2-15%	73.5±0.3	1457.7±0.4	1125.3±0.1	1999.3±0.1	332.3±0.2	874.0±0.6
0	59.2±0.1	2248.3±0.6	1746.3±0.2	3179.0±0.9	562.0±0.1	1446.0±0.4
MS3-5%	85.6±0.5	1378.7±0.5	980.0±1.0	2031.7±0.3	398.7±0.5	1051.7±0.5
MS3-10%	75.8±0.2	1452.0±0.5	1068.7±0.9	2045.7±0.1	383.3±0.5	977.0±0.6
MS3-15%	74.6±0.0	1510.0±0.5	1165.3±0.5	2066.0±0.3	344.7±0.4	900.7±0.3
0	59.2±0.1	2248.3±0.6	1746.3±0.2	3179.0±0.9	562.0±0.1	1446.0±0.4
MS4-5%	86.9±0.5	1265.3±0.3	897.3±0.2	2000.0±0.8	368.0±0.1	1102.7±0.7
MS4-10%	87.0±0.7	1304.0±0.2	922.0±1.0	2077.3±0.6	382.0±0.0	1155.3±0.0
MS4-15%	87.4±0.8	1365.3±1.0	929.7±0.5	2118.0±1.0	435.7±0.5	1188.3±0.1

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Вивчення властивостей модифікованих крохмалів для їх використання у виробництві вареників

Завдяки систематичному дослідженню модифікованого крохмалю було відібрано різні види модифікованих крохмалів, використання яких може покращити фізико-хімічні властивості оболонок для вареників, а саме: картопляний ацетатний крохмаль, картопляний гідроксипропілкрохмаль, октенілсукцинат натрію крохмаль, ацетатний крохмаль маніоки. Їх додавали до суміші сировини для приготування кришталевої оболонки для вареників у різних пропорціях. Визначено та проаналізовано фізичні показники якості кришталевої оболонки для вареників та визначено вид модифікованого крохмалю, який найбільше підходить для використання у складі оболонки для кришталевих вареників.

Кришталевий вареник є одним із представників макаронних виробів із кришталевою (прозорою) оболонкою. Його люблять споживачі за кришталево-чистий зовнішній вигляд, гладку та еластичну поверхню і міцну структуру та приємний смак. У той же час, у процесі виготовлення кришталевої оболонки вареників, вона легко ламається через втрату води, їй непросто надати форму, а готова оболонка легко тріскається. У цій статті досліджено вплив додавання, властивостей та умов обробки різних видів модифікованих крохмалів на властивості оболонки кристалічних вареників.

Шляхом визначення фізичних показників вищевказаних видів модифікованих крохмалів, та дослідженням можливості їх застосування у складі оболонок для вареників для покращення їх якості. Дослідження виявили, що властивості оболонок для вареників з додаванням модифікованих крохмалів вища, ніж у оригінальної оболонки без використанням модифікованих крохмалів, що підтверджує доцільність внесення даних видів модифікованих крохмалів в оболонку кристалічних вареників для покращення її прозорості та інших характеристик. У той же час, це забезпечує отримання необхідних показників для відповідних досліджень щодо покращення характеристик кришталевої оболонки вареника.

Дослідження показали, що використання модифікованих крохмалів, які мають специфічні властивості, може вплинути на якість оболонки вареників, підвищити її міцність і прозорість, що надасть новим продуктам високих споживчих властивостей.

Ключові слова: *модифікований крохмаль, органолептичні властивості, структура, водоутримувальна здатність, кришталеві вареники, гелеутворення.*