DERIVATION VIABILITY OF RESISTANT STARCH FROM SOME COMMON FRUIT SEEDS IN VIET NAM FOR INDUSTRIAL PRODUCTION

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ABSTRACT

The study aimed to compare the ability of extracting resistant starch (RS) from three common fruit seeds in Vietnam, namely avocado, jackfruit and mango seed. Avocado (Persea Americana) seeds, jackfruit (Artocarpus heterophyllus) seeds and mango (Mangifera indica L.) seeds were collected from local markets in Ho Chi Minh City, processed and extracted of starch. Three starch granules were then analyzed for RS content according to AOAC Standard 2002.02. Simultaneously, the effects of temperature (100, 120 °C), time (10, 15, 20 minutes) and heating methods (drying, steaming) on RS content in three starch granules were also investigated to evaluate heat-stability of these RS. The content of RS (% dry matter) in avocado seeds, jackfruit seeds and mango seeds was 23.59 %, 27.06 % and 32.12 %, respectively. Heat-stability of avocado seed RS was the least, mean while heat-stability of mango seed RS and jackfruit seed RS were higher and similar. The RS content slightly decreases after 10 and 15 minutes of heating, but significantly decreases after 20 minutes of heating. Drying reduces the RS content of the materials more than steaming. The results suggest that jackfruit seed seems to be better than avocado and mango seeds in the content and heat-stability of RS. Further studies should be conducted to choose a potential seed type for building an RS extracting processing in industrial production.

Keywords: avocado seeds, jackfruit seeds, mango seeds, resistant starch.

1. INTRODUCTION

Resistant starch (RS) is a type of starch that is incompletely digested and absorbed, but rather turned into short-chain fatty acids by intestinal bacteria. Resistant starch has attracted interest because of its positive effects in the human colon and implications for health [1] such as functions as a prebiotic, acts as dietary fiber and contributes to fecal bulking, and shortens intestinal transit time of food bolus, also may prevent the development of diabetes, obesity, and the metabolic syndrome [2]. RS can be divided into four types: RS1 is starch physically protected from digestive enzymes in grains that have not been fully milled. RS2 refers to starch in less stable, tightly packed crystalline granules that are partially resistant to hydrolysis. RS3 is
starch that has been retrograded into more highly stabile crystalline structures, and RS4 refers to starch that has been modified using chemical reagents [3].

Avocado, jackfruit and mango are widely found tropical fruits in Vietnam. Their seeds represent about 25 % for avocado, 15 ÷ 18 % for jackfruit and 17 ÷ 22 % for mango of the fruit weight. Interest in fruit seed has increased as a result of searches for alternative sources of nutritions such as starch, protein, and bioactive components. It has been reported about the chemical components of avocado, jackfruit and mango seeds, in which resistant starch account for considerable amounts. However, most of these seeds are low value by-products or even waste in Vietnam.

This study aimed to compare the amounts in raw materials and heat-stability of RS in the three types of seeds. These data would be the useful base information for scientists to select a potential RS source among avocado, jackfruit and mango seeds and build an RS extracting processing from the selected seed type which contribute to increase the added-value of by-products in general.

2. MATERIALS AND METHODS

2.1. Materials

Avocado (Persea Americana) seeds, jackfruit (Artocarpus heterophyllus) seeds and mango (Mangifera indica L.) seeds were collected from local markets in Ho Chi Minh City, cleaned under tap-water and sun-dried for two days. After that, the samples were divided into zip bags and stored at 4 ÷ 8 °C for experiments. Resistant Starch Assay Kit (K-RSTAR) was purchased from Megazyme. Other chemicals are analytical grade.

2.2. Process of starch isolation

Avocado and jackfruit seeds were soaked in 5 % NaOH to soften and peel off. Mango seed was manually peel off due to thick and hard hull. All the kernel of the three seeds was cut into small pieces of 5 ÷ 10 mm size, soaked in 0.15 ÷ 0.2 % NaHSO₃ in about 24 hours. At the end of the steeping process, the whole seed pieces and steeping solution were ground by a blender at 300 rpm for at least 30 minutes to obtain brownish white color slurry. The slurry was then filtered with a muslin cloth to collect the filtrate. The filter cake was repeatedly washed until the washing water was clear. Thereafter, the filtrate was further centrifuged at 5000 rpm for 15 minutes. Starch was collected and dried at 50 °C in about 8 hours [4].

2.3. Analysis of resistant starch content

The contents of the three seed starch including total starch (TS), digestible starch (DS) and resistant starch (RS) were analyzed using the AOAC Method 2002.02 [5]. The method is briefly described as follows: starchy sample (0.1 g) is added to a sealed tube with 0.1 M sodium acetate buffer (pH 4.5), porcine pancreatic α-amylase, and amyloglucosidase from Aspergillus niger, mixed using a vortex mixer, and digested in a 37 °C water bath for 16 h. Following the digestion step, 4 mL 100 % ethanol is added to stop the reaction, samples are centrifuged, and the supernatants are collected in a volumetric flask. Each sample is washed twice with 8 mL 50 % ethanol using a vortex mixer, centrifuged, and the supernatant is decanted and added to the collected supernatant. The pooled sample supernatants representing digestible starch (DS) fractions are diluted to 100 mL, centrifuged, and used for glucose oxidaseperoxidase (GOPOD)
assay for quantification of glucose in solution without further processing. The residue is dried in air, solubilized over an ice bath in 2M KOH to solubilize starch residue, and pH 3.8 Sodium Acetate buffer is added to adjust the pH to approximately 4.5. The dispersed starch residue representing RS fractions is digested using amylglucosidase in a 37 °C water bath for 30 min, diluted to 100 mL, and used for GOPOD assay. Total starch (TS) content of the sample is taken as the sum of DS and RS fractions.

2.4. Heat treatment

RS in natural sources or commercial RS used as materials in food technology are subjected to heat treatment, whereby steam and drying are two common thermal processes for starch products. The effect on RS content is depended on the thermal process and heat-stability of itself. The starch samples of avocado, jackfruit and mango seed were heated at different treatment conditions including temperature (100, 120 °C), time (10, 15, 20 minutes) and heating methods (drying, steaming). For drying method, samples would be heated by an oven and then cool down in a desiccant until reach room temperature. For steaming method, samples would be heated by a steaming autoclave and slowly decreased temperature inside the autoclave until reach the air pressure, then cool down in air to room temperature [6].

2.5. Statistical analysis

Every experiment was triplicated, and the results were expressed as means ± SD. Means were compared by one way analysis of variance (ANOVA) with p < 0.05 considered to be significant and presented by GraphPad Prism Software.

3. RESULTS AND DISCUSSION

3.1. Basic contents of raw materials

Basic contents of avocado, jackfruit and mango seeds including moisture and hull are presented in Table 1.

| Type of seed       | Moisture content (%) | Hull content (%) |
|--------------------|----------------------|------------------|
| Avocado seed       | 67.66 ± 2.53         | 7.80 ± 2.18      |
| Jackfruit seed     | 66.67 ± 1.94         | 10.00 ± 1.29     |
| Mango seed         | 73.98 ± 3.17         | 32.18 ± 3.71     |

Mango seed has the highest moisture content of nearly 74 % as well as the highest hull content of over 32 % which are significant superior comparing to avocado and jackfruit data. This is due to the hull structure of each type of seed. Mango seed has a thick and hard hull remaining pulp and fiber on the surface which makes it more susceptible to be contaminated during storage as well as difficult to be mechanized the peeling process.

Meanwhile both avocado and jackfruit seeds have thin skin which is smooth and easily peeled off using 5 % NaOH solution. This means the mechanization of peeling process for avocado and jackfruit seed is more feasible than for mango seed.
3.2. Comparison of TS, DS and RS contents in avocado, jackfruit and mango seed

TS, DS and RS contents of avocado, jackfruit and mango seed were analyzed using AOAC Method 2002.02. The results are showed in Table 2.

The TS content (% d.m.) is highest for jackfruit seed with approximate 65 %, followed by mango seed with 43.38 % and lowest for avocado seed with 39.41 %. The results of RS content (% d.m.) of avocado, jackfruit and mango seed are 23.59 %, 27.06 % and 32.12 %, respectively. This result is similar to previous studies by M. Lubis et al. in 2017, Manisha Sonthalia et al. in 2015 and Luis Chel-Guerrero et al. in 2016 [4, 7, 8].

Table 2. Total starch, digestible starch and resistant starch contents of avocado, jackfruit and mango seed.

| Type of seed   | TS content (% d.m.) | DS content (% d.m.) | RS content (% d.m.) |
|---------------|---------------------|---------------------|---------------------|
| Avocado seed  | 39.41 ± 1.92        | 15.82 ± 0.57        | 23.59 ± 0.11        |
| Jackfruit seed| 64.96 ± 1.78        | 37.90 ± 1.02        | 27.06 ± 0.29        |
| Mango seed    | 43.38 ± 2.03        | 11.26 ± 1.35        | 32.12 ± 0.22        |

3.3. Heat stability of RS in avocado, jackfruit and mango seed

To evaluate heat stability of RS in avocado, jackfruit and mango seed, the influence of temperature, time and heating method on the RS content was observed. Two different heating methods used were drying and autoclaving at two temperatures of 100 °C and 120 °C for three treating periods of 10, 15 and 20 minutes. Thereafter, the percentage of changes in RS contents after every heat treatment was calculated. The RS content in each unheated material was regarded as 100 %, and RS content reductions of heated samples were presented as percentage in Fig. 1, Fig. 2, Fig. 3 and Fig. 4 [6].

![Figure 1. RS content reduction (%) after 100 °C steaming in 10, 15 and 20 minutes of seeds.](image)

In the 100 °C steaming treatment (Fig. 1), RS content in the avocado seed decreased the most with 4.59 % after 10 minutes, 10.55 % after 15 minutes and 20.38 % after 20 minutes of treatment. Meanwhile, the RS reductions in jackfruit seed and mango seed were 9.47 % and
10.35 %, respectively after 20 minutes of treatment which were not statistically different (p = 0.05).

In the 120 °C steaming treatment (Fig. 2), avocado seed RS was again seemed to be strongly affected by heating with a reduction of 10.48 % after 10 minutes, 16.17 % after 15 minutes and 25.09 % after 20 minutes of treatment. Mango seed RS showed to be sensitive to high temperature when its content decreased the most with 30.20 % after 20 minutes steaming at 120 °C. Meanwhile, RS in jackfruit seed after 15 and 20 minutes steaming at 120 °C reduced 6.91 % and 20.84 %, respectively, the lowest decline among avocado, jackfruit and mango seed. These differences were statistically significant with p = 0.05.

In the 100 °C drying treatment (Fig. 3), RS in jackfruit seed again showed to be the most heat-stable to temperature among the three types of seed. RS loss in all 3 samples was < 5 % after 10 minutes, < 8 % after 15 minutes and the difference between 3 the sample was not statistically significant (p = 0.05). However, after 20 minutes drying at 100 °C, RS content of all
three seed decreased significantly, in which RS content in avocado seed decreased the most with 19.45 %, in mango seed decreased 17.34 % and in jackfruit seed decreased the least with 13.10 % (statistically different at p = 0.05).

![Figure 4. RS content reduction (%) after 120 °C drying in 10, 15 and 20 minutes of seeds.](image)

In the 120 °C drying treatment (Fig. 4), mango seed RS was the most sensitive to temperature among the three seed types and RS reduction between avocado and mango seed was fairly adjacent. Once again, avocado seed RS proved its good heat-stability when decreased the least with 22.91 % after 20 minutes treatment which was much lower comparing to avocado and mango seed RS reduction (statistically different at p = 0.05 ).

RS in these fruit seeds is type 2 which is tightly packed in a radial pattern and is relative dehydrated. This compact structure limits the accessibility of digestive enzyme and accounts for the resistant nature of RS2 [5]. When samples were treated in such a high temperature and high humidity in steaming method, water molecules would attack the boundary of RS granules, link with starch molecules and make RS2 granules become less dehydrated. Therefore, the steaming samples would be hydrolyzed more easily by α-amylase enzyme than the origin one. That explains why the RS contents in all avocado, jackfruit and mango seeds were decreased after steaming. Similar observation that RS content was reduced in cooked beans was reported by Adriana D. T. Fabbri and Y. Bavanaelthan [9, 10].

On the contrary, when samples were treated in such a high temperature and low humidity in drying method, the moisture content of sample would be decreased, results in weakening links between starch molecules in RS2 granules and dislocating the compact structure of RS2. Consequently, the RS in drying sample would be more digestible.

In general, RS content decreased slightly when the heating time was about 10 to 15 minutes, but significantly decreased when the heating time was 20 minutes. In the same condition of heating time and temperature, drying method reduced RS content more than steaming method.

4. CONCLUSIONS

In conclusion, the content of RS (% d.m.) in avocado seeds, jackfruit seeds and mango seeds was 23.59 %, 27.06 % and 32.12 %, respectively. Heat-stability of avocado seed RS was
the least, mean while heat-stability of mango seed RS and jackfruit seed RS were higher and similar. The RS content slightly decreases after 10 and 15 minutes of heating, but significantly decreases after 20 minutes of heating. Drying reduces the RS content of the materials more than steaming. RS from the three seed types need to be defined and compared their technological and functional properties to choose a potential source for deriving RS directs to industrial production.

REFERENCES

1. Homayouni A., Amir Amini, Ata Khodavirdivand Keshtiban, Amir Mohammad Mortazavian, Karim Esazadeh, Samira Pourmoradian - Resistant starch in food industry: A changing outlook for consumer and producer, Starch Stärke 66 (2014) 102-114.
2. E. Fuentes-Zaragoza, M.J. Riquelme-Navarrete, E. Sánchez-Zapata, J. A. Pérez-Álvarez - Resistant starch as functional ingredient: A review, Food Research International 43 (2010) 931-942.
3. Sajilata, M. G., R. S. Singhal and P. R. Kulkarni - Resistant starch–a review, Comprehensive reviews in food science and food safety 5 (2006) 1-17.
4. Manisha Sonthalia and Sikdar D. C. - Production of starch mango (Mangifera Indica. L.) seed kernel and its characterization, International Journal of Technical research and Application, 3(3) (2015) 346-349.
5. Barry V. Mccleary, Marian Mcnally and Patricia Rossiter - Measurement of Resistant Starch by Enzymatic Digestion in Starch and Selected Plant Materials: Collaborative Study, Journal of AOAC International 85 (3) (2002) 1103-1111.
6. Nguyen Thi Ngoc Hoi, Tran Thi Hoa, Cao Thi Hoi, Tran Le Thu - Quantity Analysis and Heat-Stable Evaluation of Resistant Starch in Vietnamese Unripe Banana (Musa basloo Sieb. Et Zucc.) and Purple Yam (Dioscorea alata Linn.), Proceeding of the 15th Asean Conference on Food Science and Technology 2 (2017) 450-455.
7. Marta Suely Madruga, Fabiola Samara Medeiros de Albuquerque, Izis Rafaela Alves Silva, Deborah Silva do Amaral, Marciane Magnani, Vicente Queiroga Neto - Chemical, morphological and functional properties of Brazilian jackfruit (Artocarpus heterophyllus L.) seed starch, Food Chemistry 143 (2014) 440-445.
8. Maryam Anwar Kasim and Santosa - Utilization starch of avocado seed (Persea Americana Mill.) as a raw material for Dextrin, Journal of Food science and Engineering 6 (2016) 32-37.
9. Bavaneethan Y., Vasantharuba S., Balakumar S., and Thayananthan K. - Effect of Different Processing Time on Resistant Starch Content of Selected Tubers, World Journal of Agricultural Sciences 11 (4) (2015) 244-246.
10. Adriana D. T. Fabbri, Raymond W. Schacht, Guy A. Crosby - Evaluation of resistant starch content of cooked black beans, pinto beans, and chickpeas, NFS Journal 3 (2016) 8-12.