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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2020 17(2):869-873. OPEN ACCESS

Drying temperature and milling size affects on physicochemical characteristics of Breadfruit (*Artocarpus altilis*) starch

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Breadfruit (*Artocarpusaltilis*) is a tropical fruit in Vietnam. It has great source of starch. It is a useful substitute of root crops. However fresh breadfruit is highly perishable at ambient preservation. It could be converted into flour as an alternative. Starch is one of the main material in the food industry. Purpose of this research aimed to evaluate the effectiveness of drying temperature and milling size to the physicochemical characteristics of breadfruit starch. In our research, different drying temperature (60, 65, 70, 75, 80°C) and milling size (45, 50, 55, 60, 65µm) were investigated. Our results showed that the breadfruit starch should be treated at drying temperature 75°C by milling size 60 µm to achieve the highest functional properties of swelling power, solubility, paste viscosity, and gel strength.

Keywords: Breadfruit starch, drying temperature, milling size, swelling power, solubility, paste viscosity, gel strength

INTRODUCTION

Breadfruit has various size, shape and surface texture (Monalisa Mohanty and Chinmay Pradhan, 2015). It is known as a traditional crop rich in starch, potassium, vitamin C, thiamine, calcium and pyridoxine (Bakare et al., 2012; Tukura and Obliva, 2015). It contains large amount of phytochemical constituents such as tannins, phenolics, glycosides, saponins, steroids, terpenoids, stilbenoids, arylben zofurons, anthraquinones, stilbenes, chalcones and flavones (Amarasinghe et al., 2008; Solanki and Nagori, 2012; Mukesh et al., 2014). It was demonstrated to have various various biological activities including antiviral, antifungal, antiplatelet, anti-arthritic, antibacterial, anti-tubercular, tyrosinase inhibitory and cytotoxicity (Jagtap et al., 2010). Breadfruit has short shelf-life under poor storage (Liu et al., 2014). It could be processed into starch for long stability (Nochera and Ragone, 2016). Starch from breadfruit can be applied as thickening agent, gelling agent, binder, texture enhancer, crispiness enhancer and coating (Beggs et al., 1997; Pietrasik, 1999; Gaines et al., 2000; Berski et al., 2011). The property of starch could be evaluated via its physicochemical characteristics responsible for its functionality (Adebowale and Lawal, 2002). Breadfruit starch has low paste clarity and retrograded property. It's necessary to survey the efficacy of drying temperature and milling size to the swelling power, solubility, paste viscosity, and gel strength of breadfruit starch production.

MATERIALS AND METHODS

Material

Breadfruit was collected from SocTrang province, Vietnam. After collecting, they must be kept in dry cool box and quickly conveyed to laboratory for experiments. They were subjected to washing, peeling, slicing, grinding, extracting, filtering, decanting, depositing, drying, milling and sifting. Lab utensils include grinder, centrifugator, tray dryer, mortar, pestle, viscometer, texture analyzer.

Researching method

Raw breadfruit was chopped into small pieces and ground with water at ratio 1.0:2.5 (starch: water) in 15 minutes to form a fine semi-liquid starch slurry. This mixture was then filtered to remove insoluble particles from semi-liquid starch milk to obtain filtrate (repeated 3 times). This filtrate was settled in 4 hours for sedimentation. The supernatant was drained out. The starch was deposited at the bottom. The starch layer was then collected and dried at different temperature (60, 65, 70, 75, 80^oC) in 8 hours. The dried flour was milled into fine powder using a mortar and pestle. Milled flour was sifted by a sieve with different screening size (45, 50, 55, 60, 65 µm). Various physicochemical parameters of breadfruit starch such as swelling power, solubility, paste viscosity, and gel strength were analyzed**.**

Physico-chemical and statistical analysis

Swelling power (g/g) was determined by procedure of Leach et al. (1959). Solubility (%) was defined as the percentage of dry soluble solids in the supernatant to the dry weight of the whole starch sample. Paste viscosity (Pa.s) was estimated by method of Rohaya et al. (2013). Gel strength (N) was measured by protocol of Noranizan et al. (2010). The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Statgraphics Centurion XVI.

RESULTSAND DISCUSSION

Effect of drying temperature to the physico-chemical attributes of breadfruit starch

In our research, drying temperatures (60, 65, 70, 75, 80°C) were verified following to other literatures cited by Ajala et al. (2014), Njintang and Mbofung (2006), and Sanni and Jaji (2003). Our results revealed that drying at 75^oC was optimal to achieve the highest swelling power, solubility, paste viscosity, gel strength. At higher temperature (80^oC), its solubility could be increased, while swelling power, paste viscosity and gel strength would be dropped down significantly (table 1). It could be explained that more broken hydrogen bonds in starch granules occurred at temperature over 75^oC (Aviara et al., 2010). According to Alicia and Fanny (2004), gelatinization temperature of breadfruit starch was presented at 73.3^oC. The soluble components would also be lost higher and produced more dilute gel (Noranizan et al., 2010). Our findings were similar to other data cited in literatures. The swelling power of the breadfruit starch rapidy increased with accelerated temperature 70 to 80^oC (Akanbi et al., 2009). Maaruf and Abdul, (2020) proved that the accelerated drying temperature dramatically decreased swelling power, paste viscosity and gel strength of cassava starch but significantly increased its solubility. The optimal drying temperature was noticed at 70°C to produce breadfruit starch with the highest swelling power, paste viscosity, gel strength. Higher drying temperature created lower swelling power and solubility of starch (Aviara et al., 2010; Akintunde and Tunde-Akintunde, 2013) and lower viscosity of starch paste (Alam and Hasnain, 2009). Thermal treatments reduced the peak viscosity and breakdown viscosity of native breadfruit starch (Marta et al., 2019).

Effect of milling size to the physico-chemical attributes of breadfruit starch

Breadfruit starch had increased value in water absorption property and swelling power over cassava starch (Eke-Ejiofor and Friday, 2019). In our study, the lowest swelling power, solubility, paste viscosity and gel strength happened at milling size of 45 µm compared to other larger milling sizes (table 2). Increasing the milling size to 60 µm significantly increased these variables. At milling size of 60 or 65 µm, there was not significant difference of physico-chemical characteristics. It could be explained that grinding created the breakdown of starch polymer chains into smaller fragments in the supernatant and decrease the capacity of starch to absorb water and swell (Hossen et al., 2011; Kerr et al., 2000). In another report, Maaruf and Abdul (2020) demonstrated that high milling size dramatically increased swelling power and solubility, paste viscosity and gel strength of cassava starch. The optimal milling size was noticed at 63 µm to produce breadfruit starch with the highest swelling power, paste viscosity, gel strength. Smaller milling size created lower swelling power (Noranizan et al., 2010), paste viscosity and gel strength (Hossen et al., 2011).

Table 1: Effect of drying temperature to the physico-chemical attributes of breadfruit starch

Drying temperature (ºC)	**60**	**65**	**70**	**75**	**80**
Swelling power (g/g)	20.37±0.00^{c}	20.85±0.02^{b}	21.24±0.00^{ab}	21.85±0.00^{a}	20.47±0.01^{bc}
Solubility (%)	13.19±0.03^{c}	13.46±0.00^{bc}	13.65±0.02^{b}	13.87±0.03^{ab}	13.99±0.02^{a}
Paste viscosity (Pa.s)	0.61±0.01^{c}	0.73±0.03^{b}	0.85±0.01^{ab}	0.98±0.02^{a}	0.68±0.03^{bc}
Gel strength (N)	0.29±0.01^{c}	0.37±0.01^{b}	0.45±0.01^{ab}	0.51±0.01^{a}	0.33±0.01^{bc}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2:Effect of milling size (µm) to the physico-chemical attributes of breadfruit starch

Milling size (µm)	45	50	55	60	65
Swelling power (g/g)	21.85±0.00^{b}	22.01±0.03^{ab}	22.14±0.01^{ab}	22.23±0.02^{a}	20.25±0.03^{a}
Solubility (%)	13.87±0.03^{b}	13.94±0.01^{ab}	13.99±0.03^{ab}	14.07±0.00^{a}	14.09±0.01^{a}
Paste viscosity (Pa.s)	0.98±0.02^{b}	1.08±0.00^{ab}	1.14±0.00^{ab}	1.20±0.01^{a}	1.21±0.00^{a}
Gel strength (N)	0.51±0.01^{b}	0.62±0.02^{ab}	0.70±0.03^{ab}	0.77±0.00^{a}	0.78±0.02^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

CONCLUSION

Breadfruit is highly appreciated for its nutritional properties as it is rich in carbohydrate, lipid and protein. In this research, we have successfully investigated the effectiveness of drying temperature and milling size to the swelling power, solubility, paste viscosity, and gel strength of breadfruit starch. These processing parameters are very important to manufacture breadfruit starch meeting quality standard and consumer requirement.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

We acknowledge the financial support for the publication provided by Ho Chi Minh City Open University, Vietnam.

AUTHOR CONTRIBUTIONS

Minh Phuoc Nguyen arranged the experiments and also wrote the manuscript.

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