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Effect of Achira (*Canna edulis* L.) Rhizome Extract on Textural and Cooking Properties of Dried Sticky Rice Noodle

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Dried sticky rice noodle was popular in daily cuisine. Achira rhizome exhibited a great amount of phenolics and soluble dietary fibers. This research evaluated achira (*Canna edulis* L.) rhizome extract incorporation in different levels (0.5÷1.5%) to the water absorption capacity, cooking loss, hardness, chewiness, tensile strength of the dried sticky rice noodle. Results showed that achira rhizome extract significantly improved the textural and cooking characteristics of this noodle. At 1.0% chira rhizome extract, the highest values of water absorption capacity (261.2%), cooking loss (6.2%), hardness (0.74 N), chewiness (1.45 Nm), tensile strength (276.4 N/cm^2) were achieved. By incorporation of achira rhizome extract in appropriate ratio, the functional properties of the dried sticky rice noodle would be improved effectively.

Keywords: Canna edulis, chewiness, cooking loss, dried sticky rice noodle, hardness, tensile strength, water absorption capacity

INTRODUCTION

Achira (*Canna* sp.) was an ornamental, perennial herb widely distributed in wetland of tropical regions. There were two types of achira: one an ornamental plant (*Canna indica*) with broad, often vividly coloured leaves, the other an edible species (*Canna edulis*) cultivated in Viet Nam for its rhizome. The rhizome was harvested after planting to extract and characterize the starch (Freddy and Adriana, 2020). Its rhizomes were thick, cylindrical and creamy white or pinkish in colour (Sari et al., 2018). Rhizomes might be sympodial, stoloniferous or tuberous. *Canna edulis* L. rhizome contained more than 90 phytochemicals including short fragment of peptide possessing different biological and pharmacological characteristics such as antimicrobial, anthelmintic potential, gonorrhea, amenorrhea, antidiabetic, and HIV-1 reverse transcriptase inhibition (Woradulayapinij et al. 2005; Nirmal et al. 2007; Gaur et al. 2014; Kumbhar et al., 2017a; Kumbhar et al., 2017b; Subhash et al., 2018; Yadav and Sisdia, 2019). Starch and flour originated from achira rhizomes had great technological possibility as functional ingredient applied in the food industry such as noodle, sauce, condiment, soup (Andrade-Mahecha et al., 2012). Achira starch was also utilized for edible coating (Piyachomkwan et al., 2002; Hernandez et al., 2008). The processing of edible achira included grinding the rhizome to extract the starch. This starch was very digestible.

Generally, noodle was a staple food prepared from dough of grain flour that was rolled flat and cut into long thin strips. Different kinds of noodle were made from wheat flour, rice flour, sorghum starch flour, oat flour, millet flour, soy flour (Collins and Pangloli, 1997; Beta and Corke, 2001; Kim et al., 2011; Dissanayake and Jayawardena, 2016;

Kudake et al. 2017; Huh et al. 2019). Sticky rice flour was the main ingredient to make the dried sticly rice noodle. While long, thin strips might be the most widely recognized. Various assortments of noodle were cut into waves, helices, cylinders, strings, or shells, or collapsed over, or cut into different shapes. Noodle was typically cooked in bubbling water, with cooking oil or salt included. Noodle could be refrigerated for transient stockpiling or dried for long consumption (Azhari et al. 2018). Clear noodles were prepared from canna starches. The effects of amount of gelatinized starch, moisture content of dough, and holding temperature after cooking on noodle appearance were investigated (Ruethaipak et al.2005). Spray drying, drum drying and extrusion cooking were verified to find out the best treatment for pre-gelatinization of *Canna edulis* starch for noodle processing (Stalin et al. 2012). Objective of our study verified the impact of achira (*Canna edulis* L.) rhizome extract incorporation in different levels to the textural and cooking characteristics of the dried sticky rice noodle.

MATERIALS AND METHODS

Material

Sticky rice flour and achira (*Canna edulis* L.) rhizome were purchased in local market. Achira (*Canna edulis* L.) rhizome was rinsed in tap water to remove dirt and foreign matter. Utensils included analytical balance, texture analyzer.

Researching method

*Canna edulis*L. rhizomewas extracted bypulverised raw material to fine powder. 50 gram of powder was then extracted with 500 ml of ethanol (70%). After 2 hours, the obtained hydro-alcoholic extract was filtered and concentrated using rotary evaporator. Extract was kept at 4ºC forexperiment. Sticky rice flour was thoroughly blended with *Canna edulis*L. rhizome extract (0, 0.5, 0.75, 1.0, 1.25, 1.5%), tapioca starch (10%), salt (2.5%), water (30%) by a mixer for 30 minutes. The dough was set to rest for 90 minutes at ambient environment before being sliced into noodle. The prepared noodle was then dried at 55ºC for 18 hours under convective dryer. The dried sticky rice noodle was kept in plastic bag ready for physical testing.

Physical evaluation

250 g of the dried sticky rice noodles were boiled in 1000 mL water for 5 minutes. The water absorption capacity (%) was estimated as the difference in the weight of sticky rice noodles before and after cooking (Galvez and Resurreccion, 1992). To estimate the cooking loss, cooked noodles were washed with chill water, drained for 5 minutes and weighed. The cooking loss was counted as the difference between the weight of cooked noodles before and after draining (Huh et al., 2019).Hardness (N), Chewiness (Nm)were estimated by a compression testdescribed by Champagne et al. (1999). Tensile strength (N/cm^2) was determined by Texture Analyserdescribed by Zhu et al. (2010).

Statistical analysis

The experiments were run in triplicate with different groups of samples. The data were presented as mean±standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI.

RESULTSAND DISCUSSION

Water absorption capacity and cooking loss of the dried sticky rice noodle incorporated with achira (*Canna edulis* L.) rhizome extract

The achira starch was characterized by very large granules, high amylose content, clear paste, high viscosity, high retrogradation, and high resistance to hydrolysis by a-amylase (Piyachomkwan et al. 2002; Hung and Morita, 2005; Cisneros et al., 2009). However, the yield of achira starch was low (about 12 g starch/100 g fresh rhizomes) (Leonel et al. 2002). Table 1 presented the water absorption capacity and cooking loss of the dried sticky rice noodle incorporated with *Canna edulis* L. rhizome extract during cooking. Water absorption capacity implied the hydration rate. It influenced the textural characteristics of noodles (Yadav et al. 2011). Compared to the water absorption capacity of the control (201.3%), *Canna edulis* L. rhizome extract incorporation significantly increased the water absorption capacity of the sticky rice noodle. With 1.0% *Canna edulis* L. rhizome extract supplemented, water absorption capacity achieved highest at 261.2%. Possitive effect of *Canna edulis* L. rhizome extract enhanced the water binding capacity through improved gelatinisation (Suhendro et al. 2000). Moreover, due to hydrophilic property of achira flour, it's possibly related to the high capacity of moisture retention by the starch (Andrade-Mahecha et al. 2012).

Table 1: Water absorption capacity (%) and cooking loss (%) of the dried sticky rice noodle incorporated with *Canna edulis* L. rhizome extract

Parameters	***Canna edulis* L. rhizome extract (%)**					
	Control	**0.5**	**0.75**	**1.0**	**1.25**	**1.5**
Water absorption capacity (%)	201.3±0.2^{d}	224.6±0.3^{c}	248.1±0.0^{b}	261.2±0.2^{a}	255.0±0.1^{ab}	231.7±0.2^{bc}
Cooking loss (%)	21.5±0.1^{a}	13.6±0.2^{b}	9.5±0.1^{c}	6.2±0.0^{d}	7.9±0.2^{cd}	11.3±0.1^{bc}

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

Table 2: Hardness (N), chewiness (Nm), tensile strength (N/cm^2) of the dried sticky rice noodle incorporated with *Canna edulis* L. rhizome extract

Parameters	***Canna edulis* L. rhizome extract (%)**					
	Control	**0.5**	**0.75**	**1.0**	**1.25**	**1.5**
Hardness (N)	0.51±0.01^{d}	0.59±0.00^{c}	0.65±0.03^{b}	0.74±0.02^{a}	0.69±0.01^{ab}	0.61±0.03^{bc}
Chewiness (Nm)	0.82±0.03^{d}	1.08±0.01^{c}	1.21±0.00^{b}	1.45±0.03^{a}	1.32±0.00^{ab}	1.17±0.02^{bc}
Tensile strength (N/cm^2)	193.1±0.2^{d}	247.2±0.3^{c}	259.5±0.1^{b}	276.4±0.2^{a}	268.1±0.1^{ab}	252.4±0.0^{bc}

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

The high water absorption capacity of the noodle may be due to the existing of high amount of polar amino acid residues from proteins, which had an affinity for water molecules, but the high hydrophilicity of the cellulose present in the fibers could also account for this fact (Yusuf et al., 2008). Proteins and fibers improved the water absorption capacity of flours because these constituents included hydrophilic segments, such as polar or charged side chains (Lawal et al. 2007). However, when *Canna edulis* L. rhizome extract supplemented at 1.25% and 1.5%, the water absorption capacity of the dried sticky rice noodle decreased afterwards. This could be explained by the high content of soluble dietary fibre and phenolics in *Canna edulis* L. rhizome extract could lower the hydration power of flour (Zhang et al., 2010; Zhang and Wang, 2011). This phenomenon was reported by incorporation of curdlan in noodle making with tofu (Xin et al., 2018). Cooking loss reflected the ability of noodle to preserve the textural integrity during the cooking process (Yadav et al. 2011). Compared to the cooking loss of the control (21.5%), *Canna edulis* L. rhizome extract incorporation significantly decreased the cooking loss of the sticky rice noodle. With 1.0% *Canna edulis* L. rhizome extract fortified, cooking loss was recorded at lowest level (6.2%). This could be elaborated by the hydrogen bonding interactions between *Canna edulis* L. rhizome extract and starch. Result implied that *Canna edulis* L. rhizome extract had possitve effect in improvement of structural integrity of the dried sticky rice noodle during cooking. Ruethaipak et al. (2005) examined the effects of amount of gelatinized starch, moisture content of dough, and holding temperature after cooking on noodle appearance prepared from canna starch. They found that the cooking losses were 0.93% to 0.55% dry weight. Stalin et al. (2012) proved that noodle prepared from *Canna edulis* showed lower cooked weight and solid loss than commercial samples.

Textural characteristics of the dried sticky rice noodle incorporated with achira (*Canna edulis* L.) rhizome extract

Achira flour had higher fiber, protein, and lipid content as compared to the cassava flour and more fiber content than the sweet potato flour (Aryee et al., 2006; Osundahunsi et al., 2003). Table 2 showed thehardness (N), chewiness (Nm), tensile strength (N/cm^2) of the dried sticky rice noodle incorporated with *Canna edulis* L. rhizome extract in different ratio. The highest values of hardness (0.74 N), chewiness (1.45 Nm), tensile strength (276.4 N/cm^2) were noticed at 1.0% of *Canna edulis* L. rhizome extract supplemented into dough. This could be correlated with stronger interaction between water molecule and hydroxyl group of *Canna edulis* L. rhizome extract which could intensify the interaction between sticky rice flour and tapioca. Similar findings were also literatured on rice-based noodle (Kim et al., 2011) and okara cookie (Park et al., 2015). Supplementation of curdlan to tofu noodle could significantly increase hardness, chewiness and tensile strength (Xin et al., 2018). The filled structural network induced higher resistance to stress leading to better hardness, chewiness and tensile strength (Chen et al., 2016). Ruethaipak et al. (2005) examined the effects of amount of gelatinized starch, moisture content of dough, and holding temperature after cooking on noodle appearance prepared from canna starch. They found that tensile stresses were 17.44 to 22.77 g/mm^2.

CONCLUSION

In order to satisfy the greater demand of healthy foodstuff, the dried sticky rice noodle incorporated with achira (*Canna edulis* L.) rhizome extract was developed. As an easy-to-cultivate crop with high yield, achira rhizome was ground, washed and strained to extract the starch. The high viscosity and clear paste of the achira rhizome extract were a ideal to utilize as a thickening agent in noodle preparation. This reseach focused on the effect of achira rhizome extract incorporated into the sticky rice flour in making the dried sticky rice noodle. Rhizome extract was significantly affected water absorption capacity, cooking loss, hardness, chewiness, tensile strength of this noodle.

CONFLICT OF INTEREST

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

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AUTHOR CONTRIBUTIONS

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

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