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Effect of Blanching on Properties of Water Yam (*Dioscorea alata*) Flour

Harijono, Teti Estiasih, Dinar S. Saputri and Joni Kusnadi
Department of Food Science and Technology, Brawijaya University, Malang, Indonesia

Abstract: Properties of flour from blanched tubers of two water yam (*Dioscorea alata*) cultivars were compared with those from the non blanched ones. The results showed that the proximate composition of flours from the yellow cultivar was different from that of the purple cultivar. Steam blanching (97±2°C, 7 min) on the purple cultivar resulted in more significant reduction on yield and the Lightness (L) value. However, it had significant effect on some components of the flours such as protein, ash, amylose and fiber. Results of proximate composition showed crude fat yellow and purple water yam ranging from 0.4 to 0.55%, crude protein 5-8%, dietary fiber 16-26% and starch 41-76%. Starch granule size between 20-40 μm. Blanched yellow water yam flour has the highest water and oil absorption which is 2.02 and 1.18 g/g. Dioscorine and water soluble polysaccharides, bioactive components from *Dioscorea*, of purple water yam flour are larger than the yellow flour. Purple water yam flour is better to be proceed as a functional food because it has a high peak viscosity, more stable to heat and has greater content of bioactive compounds. Steam blanching decrease the yield of dioscorine and water soluble polysaccharide.

Keywords: *Dioscorea alata*, dioscorin, diosgenin, functional properties, water soluble polysaccharides

INTRODUCTION

Water yam (*Dioscorea alata*, L.), the most widely grown among the family of *Dioscorea* spp., is known to contain bioactive compounds such as dioscorine, diosgenin and water soluble polysaccharides. Dioscorine, water soluble storage protein of yam is reported to inhibit ACE (angiotensin converting enzyme) activity (Liu *et al*., 2007) which plays an important role in management of hypertension. Dioscorin accounts for about 90% of the extractable water soluble protein found in *Dioscorea* species (*Dioscorea batatas*, *Dioscorea alata*, *Dioscorea pseudojaponica*), as estimated by immunostaining method (Hsu *et al*., 2002). Diosgenin is a sapogenin steroid compound that can be absorbed through the gut and plays an important role in the control of cholesterol metabolism (Roman *et al*., 1995; Chapagain and Wiesman, 2005). It also shows esterogenic effect (Li *et al*., 2012) and anti tumor activity (Moalic *et al*., 2001). Water soluble polysaccharide is plant material that is not hydrolized by enzymes secreted by human digestive tract (Li *et al*., 2002). Other previous finding indicated that soluble fibers from oats, wheat and barley may increase digesta viscosity and the thickness of the unstirred layer in the small intestine. These soluble fibers show that gelling and thickening properties can decrease cholesterol and triglyceride absorption, reabsorb bile acids, increase fecal bile acid excretion and accelerate the synthesizing of hepatic cholesterol into bile salts (Yu *et al*., 2005).

Water yams are a valuable source of carbohydrate to supply human needs of food, especially in arid regions. Two varieties of water yam based on their flesh colour are purple (*Dioscorea alata* L. *var. purpurea* (*Roxb*) M. Pouch) and yellow (*Dioscorea alata* L.). In order to extend the shelf life and utilization, fresh tubers are usually processed into flour as an intermediate products. In India, water yam flour is used to prepare "papads" which resembles to wafer (Siddaraju *et al*., 2010). Adeleke and Odedeji (2010) reported that water yam flour was used as composite flour with wheat in production of bakery products such as cookies, bread and cakes to reduce the cost of production. The properties of flour vary considerably with botanical source, an environmental condition and composition and structure of starches (Mweta, 2009). Siddaraju *et al*. (2010) compared the functional properties of water yam flour with rice flour. They found that the bulk density was similar. The water absorbtion capacity was higher, but the oil absorption capacity was lower than that of rice flour, respectively.

Blanching is a short and mild heat treatment prior to the main process for the purpose of enzymes inactivation, modifying texture, preserving color, flavor and nutritional value and removing trapped air. Hot water and steam are the most commonly used heating media for blanching in industry (Corcuera *et al*., 2004).

Corresponding Author: Dinar S. Saputri, Department of Food Science and Technology, Brawijaya University, Malang, Indonesia

Discoloration phenomenon on fresh tubers has long been known to be associated with enzymatic activity, e.g., due to the action of polyphenoloxidases and peroxidases. These enzymes are inactivated by blanching (Akissoe *et al*., 2002). However, blanching reduces nutritional value of foods due to nutritions leach out or degrades by heating (Corcuera *et al*., 2004). Starch properties may also be altered by heating (Kouassi *et al*., 2010). This study was aimed to assess the effect of blanching on the nutrients and functional properties and the contents of bioactive compounds of water yam flour.

MATERIALS AND METHODS

Materials: Two varieties of water yam, purple water yam (*Dioscorea alata* L. *var*. *purpurea* (*Roxb*) M. Pouch) and yellow water yam (*Dioscorea alata* L.) were obtained from local farmers in Tuban, East Java, Indonesia. Reagents were analytical grade, unless otherwise stated.

Flour preparation: Tubers were peeled, washed and sliced (ca 2 mm thick) and divided into two parts. One part of the slices was directly air dried using an oven at 60±2°C for 5 h (non blanched flour). Another part was soaked in water (25±2°C) for 5 min and blanched on hot steam (97±2°C) for 7 min before drying as above. The dried chips were respectively ground to pass 80 mesh sieve. The flour was packed and sealed in 8 mm-thick polypropylene and stored at 0±2°C until used. The yields of flour processing were determined accordingly.

Properties analysis:

Physical and chemical analysis: The colors of flour were measured using a Minolta portable chroma-meter. The hunter lab colour coordinates system L* a* and b* values were recorded (Jimoh *et al*., 2009). pH of the flours were determined using method by Kafilat (2010). Starch granule microstructure was determined using Scanning Electron Microscope (FEI, type: Inspect-S50). Flour samples were applied on a stubholder using double sided adhesive tape and the flour was coated with pure gold and carbon in a vacuum evaporator. An accelerating potential of 10 kV was used during micrography. Total acid was determined by titration method (Adeleke and Odedeji, 2010) and moisture, fat, protein, ash and crude fiber contents were analyzed according to the standard methods of AOAC (2005). A level of dietary fiber was determined by multienzyme method (Asp *et al*., 1983).

Pasting and functional properties analysis: The flour pasting properties were determined using Rapid Visco Analyser (RVA) *TechMaster* (Newport Scientific Pty Limited, Australia). Functional properties determined were swelling power, water and oil holding capacities (Mbougueng *et al.*, 2008), bulk density (Eltayeb *et al*., 2011) and foam capacity and stability. Foam capacity and stability were determined on samples of water suspension of flour (1%) according to the method of Appiah *et al*. (2011). The suspension of flour was stirred for 5 min at 500 rpm and the volume increase soon after stirring was measured and considered as the foam capacity. The foam stability was measured as the foam volume after 5 min stirring.

Bioactive compounds analysis: Bioactive compounds were analyzed including Water Soluble Non starch Polysaccharides (WSNP), dioscorin and diosgenin. WSNP was determined by a modified method of Ohashi *et al*. (2000). Three hundred mL of distilled water was heated to about 75-80°C. Alumunium sulfate (10% w/w with flour) was added, 6 g of flour were then added and stirred for 60 min. The mixture then centrifuged and the filtrate was coagulated in twice volume of 96% ethanol overnight.

Three grams of flour were added to 9 mL aquadest. Dioscorin, a water soluble protein of yam, was separated from the flour suspension by precipitation using tricholoroacetic acid after the solution was centrifuged for 15 min at 3000 rpm. Crude protein extract was further analyzed by SDS PAGE to confirm the presence of dioscorin (Liao *et al*., 2006).

Diosgenin was extracted by the modified method of Trivedi *et al*. (2007) prior to HPLC analysis by using HPLC column C-18. Accurately weighed 30 g of flour were added to round bottom flask and 100 mL of 2.5 M ethanolic sulfuric acid was added. The mixture was refluxed for 4 h at 80°C cooled, filtered and washed with 2, 5 M ethanolic sulfuric acid (3×100 mL). The filtrate was diluted twice of the initial volume with water. This solution was then extracted with chloroform (4×20 mL). The experimental HPLC conditions were an isocratic binary system of acetonitrile/water (90:10), a flow rate of 1 mL/min and a temperature of 35°C. Detection was performed at 194 nm (Nino *et al*., 2007).

RESULTS AND DISCUSSION

Physical and chemical characteristics: Blanching tended to decrease the yield of flour (Table 1). Purple water yam had higher yield than yellow one, this was possibly related to higher moisture content of fresh tuber that evaporated during flour processing in drying step. The color of blanched water yam flour is brighter than the non blanched flour, either purple or yellow water yam. This was indicated by higher value of L (lightness) of blanched flour. According to Akissoe *et al*. (2002) blanching inactivates polyphenolase that responsible to enzymatic browning. Water yam exhibits phenolic content of 69.9 to 421.8 mg/100 g dry sample (Cornago *et al*., 2011) that could oxidize to from

Table 1: Physical and chemical properties of water yam flours

Water yam cultivars	Purple non blanched	Purple blanched	Yellow non blanched	Yellow blanched
Physical properties:				
Yield (%)	28.99±7.71	21.03±10.23	20.66±1.55	19.34±0.88
pH	6.55±0.01	6.64±0.01	6.53±0.01	6.44±0.01
Color:				
L*	49.10±2.09	53.08±0.72	65.55±0.56	65.58±0.09
a*	17.23±0.05	17.85±0.10	15.23±0.09	15.13±0.05
b*	6.73±0.05	8.88±0.43	15.93±0.36	18.05±0.10
Chemical properties:				
Moisture (%)	4.40±1.01	5.24±1.51	5.86±0.37	6.09±0.28
Protein (%)	8.33±0.02	6.84±0.07	6.00±0.02	5.62±0.02
Fat (%)	0.49±0.02	0.42±0.01	0.40±0.09	0.51±0.06
Ash (%)	3.62±0.07	2.36±0.05	3.93±0.06	3.16±0.02
Crude fiber (%)	5.73±0.12	4.44±0.24	4.89±0.22	4.07±0.15
Dietry fiber (%)	26.29±0.29	26.02±0.04	19.78±0.17	16.66±0.27

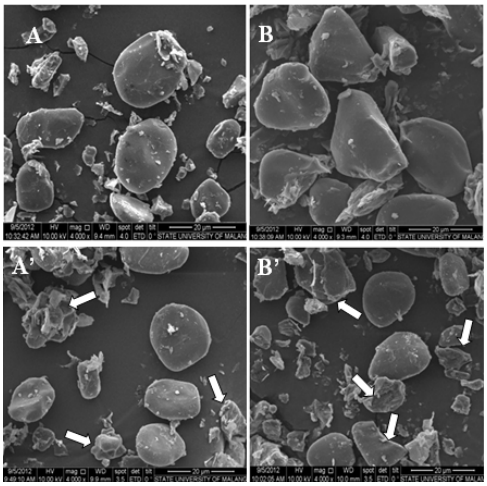

Fig. 1: Intact granule of non blanched purple (A) and yellow (B) water yam flour; broken granule (pointed arrow) of blanched purple (A') and yellow (B') water yam flour

brownish compounds. This reactions is catalyzed by polyphenolase (Akissoe *et al*., 2002) and inactivation of this enzyme could prevent phenol oxidation that resulted in brighter color. It was seemed that blanching did not affect the acidity of flour that indicated by pH value in the range of 6.4-6.6. SEM examination showed that water yam flour had heterogeneous starch granule. The starch granule size ranged between 19-46 µm in non blanched purple water yam flour, 17-38 µm in blanched purple water yam, 27-37 µm in non blanched yellow water yam flour and 24-33 µm in blanched yellow water yam flour. This size is bigger than corn starch granule which is in the range of 15-20 µm (Tam *et al*., 2004). Blanching treatment slightly affected starch granule size, that indicated by bigger starch granule size for non blanched flour. Perhaps, during steam blanching some starch granules gelatinized due to water absorption and heat treatment, that caused starch granules swelled and collapse. Figure 1 showed some broken starch granule in blanched flour while non blanched flour has more intact starch granule. Particle size affects digestibility of the yam starches, that smaller starch granules are more digestible than the larger ones (Riley *et al*., 2006).

Blanching treatment increased moisture content of water yam flour, either purple or yellow water yam. This result in accordance to the result of Sobukola *et al*. (2008) that blanching on potato before frying activated pectin esterase enzyme, resulting in porosity decrease and made higher moisture content. Data in Table 1 showed that protein content of water yam flour was in the range of 5.63-8.33%. Water yam flour had lower protein content than wheat flour (10%) (Enriquez *et al*., 2003), but higher than other *Dioscorea* spp. such as *D. bulbifera* (1.2%), *D. cayanensis* (1.3%) and *D. rotundata* (1.8%) (Igyor *et al*., 2004). Steam blanching significantly affect the protein content of water yam. All water yam flour had low fat content and tuber is not a good source of fat. Ash content of both purple and yellow water yam flour was 2-4%, that in accordance with the result of Baah (2009) and Adegunwa *et al*. (2011). There was a correlation between flour lightness and ash content. Awoyale *et al*. (2010) reported that yam flour with higher ash content was less acceptable, but in this case, the lightness of water yam flour was also affected by the natural yellow and purple pigment.

Dietary fiber of both purple and yellow water yam flour was 16-26% (Table 1). This result was higher than that reported by Baah (2009) for water yam flour from Ghana and Nigeria (8%). High dietary fiber is one of the superiority of water yam that this tuber is might be processed for fiber rich foods or functional foods. Crude fiber, as part of dietary fiber, of water yam flour was 4.4-5.7% that meant most of dietary fiber of water yam flour comprised of soluble dietary fiber. Each dietary fiber components had specific functions on health and soluble dietary fiber showed more functions than crude fiber such as, increased satiety with apetite reduction, slower rate of glucose absorption, reduce bile salt reabsorption, altered colonic microflora composition, inrease water, sodium and mineral absorption (Schultz, 2011).

The starch content of water yam flour was 41-77% and flour consisted of 63-72% starch (Du Toit, 2004). Starch content of purple water yam flour (71-77%) was

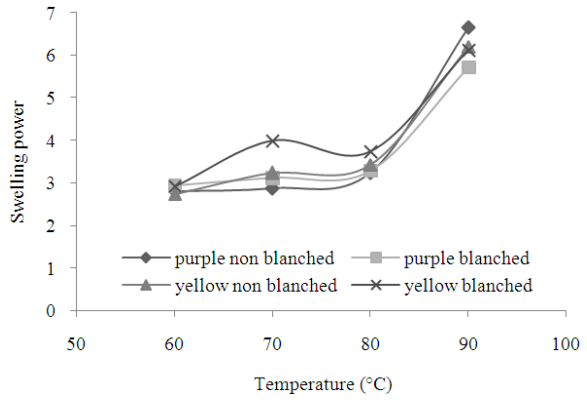

Fig. 2: Swelling power of *Dioscorea alata* flour

higher than yellow (41-60%). Water yam flour, both yellow and purple, had higher amylopectin (64-80%) than amylose (20-36%). Generally, starch has higher amylopectin (70-80%) than amylose (20-30%) (Chaplin, 2012). Wireko-Manu *et al*. (2011) and Behera *et al*. (2009) reported starch content of *Dioscorea alata* flour was 60.42-77.56%, with 21.69-31.56% amylose. Blanching treatment slightly affected starch content that blanched flour had lower strach content than non blanched flour. In general, blanching of tuber in flour processing decreased water soluble content such as protein, ash, fiber and starch content due to some leaching out during steam blanching.

Functional properties: Swelling power of purple and yellow water yam flour increased along with the increase of heating temperature (Fig. 2). When starch is heated with exceed amount of water, granule hydrate progressively, hydrogen bonds are ruptured resulting in crystaline regions being converted into amorphous regions and granules continue to imbibe water and swell (Ratnayake *et al*., 2002). Large starch granules are known to swell faster (Adejumo *et al*., 2011). Non blanched purple water yam flour had the largest starch granule (about 46 µm) resulting in highest swelling power. Therefore, blanching treatment decreased swelling power of water yam flour. Non starch polysaccharides also affects granule swelling (Caprita *et al*., 2010). Swelling power of water yam flour was lower than other tuber flour such as *D. rotundata* flour (5.45-8 g/g) (Kafilat, 2010), sweet potato flour (6.01 g/g) (Adeleke and Odedeji, 2010) and potato (40 g/g) (Srichuwong *et al*., 2005). The variation in the swelling power indicates the degree of exposure of the internal structure of the starch present in the flour to the action of water (Kafilat, 2010). Swelling and gelatinization properties are controlled, in part, by the molecular structure of amylopectin, starch compositions and granule architecture (crystalline to amorphous ratio) (Srichuwong *et al*., 2005).

Foaming capacity of non blanched purple water yam flour was the highest. Foaming capacity and stability is related to protein content because some proteins have surface active properties to entrap gas bubbles. Soluble protein can reduce surface tension at interface between air bubbles and surrounded liquid (Eltayeb *et al*., 2011). Protein also able to undergo rapid conformational change and rearrangement at the interface and form a cohesive viscoelastic film via intermolecular interactions to stabilize foam (Adebowale *et al*., 2005). Most protein of water yam or yam is water soluble protein (Liu *et al*., 2006) and the ability of proteins to stabilize foaming is determined of their water solubility (Baljeet *et al*., 2010). Blanching treatment reduce protein content (Table 1), so the foaming capacity and stability decreased. Non blanched purple water yam flour has the highest foam capacity but lowest in foam stability. Adeleke and Odedeji (2010) reported that flours with high foaming ability could form large air bubbles surrounded by thinner and less flexible protein films. These air bubles might be easier to collapse and consequently lowered the foaming stability.

Bulk density showed the comparation of weight and volume which influences package design and could be used in determining the type of packaging material required (Odadeji and Oyeleke, 2011). Loose density of water yam flour was 0.62-0.67 g/mL while packed density was 0.82-0.88 g/mL. Adejumo *et al*. (2013) reported that blanching was not affect loose and packed density in yam flour. This result is higher than other *Dioscorea* species such as *D. bulbifera* (0.52 g/mL) and *D. cayanensis* (0.5 g/mL) (Igyor *et al*., 2004).

The water absorption capacity and oil absorption capacity of blanched yellow water yam flour was the highest (2.02 and 1.18 g/g) compared to other flour, while blanched purple water yam flour was the lowest water absorption capacity (1.64 g/g) and blanched yellow water yam has the lowest oil absorption capacity (0.96 g/g). Iwuoha (2004) reported water absorption capacity of water yam in Nigeria (1.77 g/mL) which was higher than *D. rotundata* (1.74 g/mL) and *D. cayanensis* (1.76 g/mL). Oil absorption capacity is higher than sweet potato flour (0.65 g/mL) (Adeleke and Odedeji, 2010).

Protein has both hydrophilic and hydrophobic properties and can interact with water in foods. Low water absorption capacity is related to low polar amino acids in flour, conversely low oil absorption capacity is related to high non polar amino acids. Carbohydrate is also been reported to influence water absorption capacity of foods. The high oil absorption capacity makes the flours suitable to enhancement flavor and mouth feel (Appiah *et al*., 2011). Water absorption capacity is important in the development of ready to eat foods and a high absorption capacity may assure product cohesiveness (Ogunlakin *et al*., 2012). Functional properties of water yam flour were presented in Table 2.

Table 2: Functional characteristics of blanched and non blanched purple and yellow water yam flour

Water yam flour	Bulk density (g/mL) Loose density	Bulk density (g/mL) Packed density	Water absorption capacity (g/g)	Oil absorption capacity (g/g)	Foam capacity (%)	Foam stability (%)
Purple non blanched	0.62±0.01	0.83±0.01	1.88±0.04	1.11±0.07	44.67±7.57	90.19±0.04
Purple blanched	0.64±0.02	0.84±0.01	1.64±0.07	1.06±0.09	16.67±1.15	94.87±1.67
Yellow non blanched	0.65±0.00	0.86±0.02	1.68±0.03	0.96±0.00	15.33±3.05	93.06±0.19
Yellow blanched	0.67±0.01	0.88±0.01	2.02±0.22	1.18±0.04	14.00±2.00	92.41±0.89

Table 3: Pasting properties of water yam flour

Sample	(RVU) Peak viscosity	(RVU) Trough viscosity	(RVU) Breakdown	(RVU) Final viscosity	(RVU) Setback	Gelatinization time (min)	Gelatinization temperature (°C)
Purple non blanched	222.08	221.67	0.420	260.92	40.08	12.67	80.90
Purple blanched	73.67	73.75	-0.083	110.58	36.83	13.00	91.80
Yellow non blanched	111.58	115.50	0.080	153.75	42.25	12.73	83.35
Yellow blanched	47.00	46.67	0.330	70.00	23.33	12.27	84.95

Pasting properties: Peak viscosity is the point at which gelatinized starch reaches its maximum viscosity during heating in water. It indicates the water binding capacity of starch (Tsakama *et al*., 2010). Peak viscosity of water yam flour was 47-222 RVU (Rapid Visco Analyser Unit) with 1 RVU≈12cP (Cui *et al*., 2010), that was in accordance to the result of Kafilat (2010) and Baah (2009) that reported the peak viscosity of water yam flour was 70-280 RVU. Zaidul *et al*. (2007) reported that lower amylose content was associated with higher peak viscosity, on the contrary, Baah (2009) showed that amylose content did not affect peak viscosity. In this study, amylose content of blanched purple water yam flour was higher than non blanched yellow water yam flour, but had higher peak viscosity. Jimoh *et al*. (2009) reported that water absorption capacity, biology and morphological properties of starch affected peak viscosity.

Trough viscosity showed starch ability to cook and granule weakness. Breakdown viscosity is the decrease of starch viscosity when heated at 95°C and showed its dough stability. Higher breakdown viscosity showed lower ability of sample to withstand heating and shear stress during cooking (Adebowale *et al*., 2005). Trough viscosity of water yam flour was 46-221 RVU (Table 3) and this was in accordance to the result of Kafilat (2010) and Baah (2009). Meanwhile, breakdown viscosity was 0.1-0.4 RVU. Our result was lower than previous study by Baah (2009) with *D. alata* flour from Nigeria (2.4-61.6 RVU) that meant water yam flour in Indonesia was more stable at high temperature.

Final viscosity formed at the end of cooling (50°C) that used to define a particular quality of starch and indicates the stability of cooked starch paste in actual use (Tsakama *et al*., 2010). Setback viscosity is the recovery of the viscosity during cooling of the heated starch suspension (Kaur *et al*., 2006). Starches with high setback viscosity would tend to have stiffer pastes, but are susceptible to weeping when used as filling in frozen product application (Ocloo *et al*., 2011). Final viscosity of water yam flour was 70-261 RVU and the

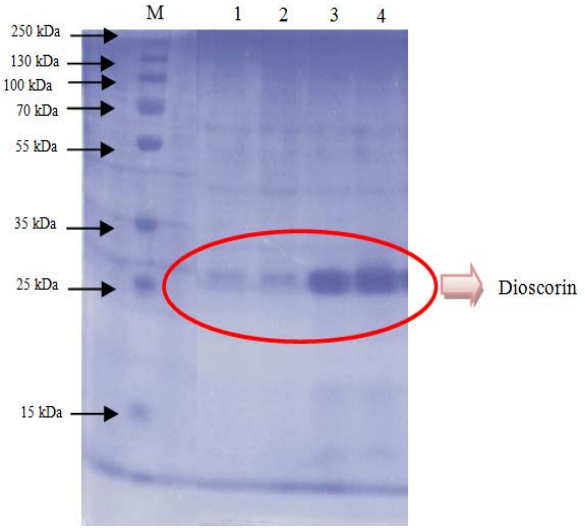

Fig. 3: SDS PAGE of water yam flour
M: Marker; 1: Purple non blanching; 2: Purple blanching; 3: Yellow non blanching; 4: Yellow blanching

setback viscosity ranging from 23-42 RVU (Table 3). This result was similar to previous study by Baah (2009) who reported setback viscosity ranging from 32-79 RVU, that meant water yam flour had tendency to form gel during cooling.

Temperature and time when starch reaches its maximum swelling and rupture is called gelatinization temperature and gelatinization time (Fennema, 1976). Gelatinization temperature of water yam flour was 80-92°C. This result was similar to previous study of Baah (2009) for water yam from Ghana. Gelatinization time of water yam flour was around 12 min. Gelatinization time of water yam flour was longer than wheat, sweet potato and cassava starch which have 4-5 min of gelatinization time (Zaidul *et al*., 2007). It meant that water yam starch required longer heating time for gelatinization. Blanching reduce peak viscosity. Lower peak viscosity due to the lower swelling power and lower starch content (Baah, 2009) of blanched flour.

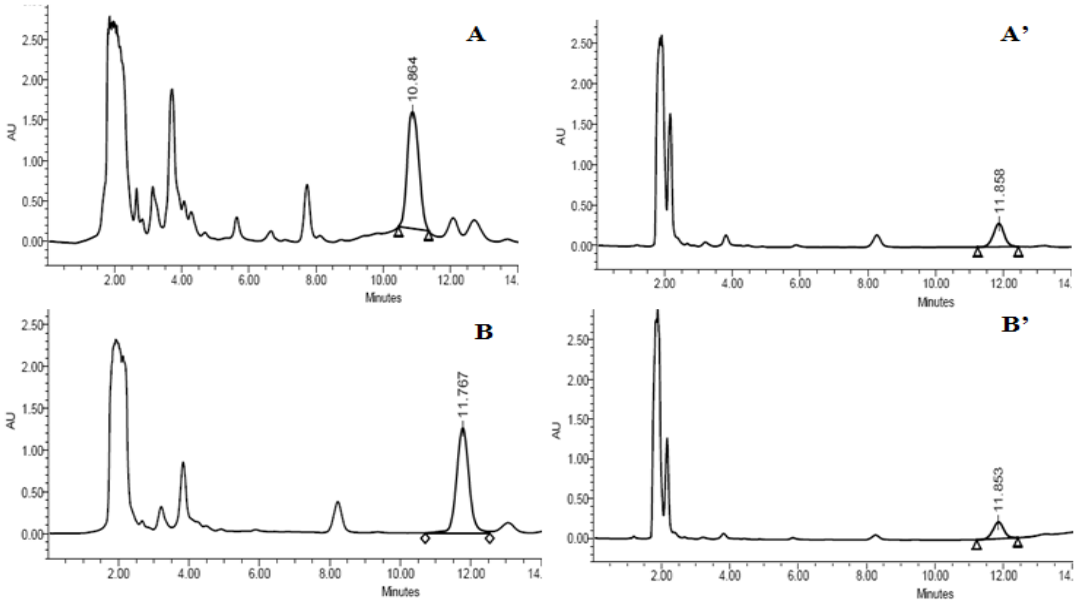

Fig. 4: HPLC chromatogram of diosgenin in water yam flour
A: Purple non blanching; A': Purple blanching; B: Yellow non blanching; B': Yellow blanching

Purple water yam flour has higher viscosity than the yellow one. Viscosity is largely influenced by granule size and swelling power, the larger the granules size, the higher the swelling power (Adejumo *et al*., 2011). Purple water yam flour has bigger granule size (27-46 µm) and higher swelling power.

Bioactive compounds: Water Soluble Non starch Polysaccharide (WSNP) or hydrocoloid is usually used in food industries to achieve good viscosity, stability, texture and appearance. WSNP contributes to viscous aqueous solutions, even at low concentration (Soma *et al*., 2009). It has been reported that water soluble polysaccharide extracted from yam flour have less detrimental effect on the baking performance (Dodic *et al*., 2007). WSNP content of blanched and non blanched purple water yam flour were 0.11 and 0.12% while blanched and non blanched yellow water yam flour were 0.102% dan 0.105%. This result is lower than WSNP yield in *D. hispida* (9-12%) (Estiasih *et al*., 2012). Glucomannan, water soluble polysaccharide extracted from elephant yam (*Amorphophallus konjac*) reported by Keithley and Swanson (2005) may posses properties that promote weight loss when used in conjunction with either a normocaloric or hypocaloric diet.

Hsu *et al*. (2002) reported that dioscorin appeared as a single protein band of molecular weight of about 32 kDa. SDS PAGE analysis in this study showed an apparent band between 25 and 35 kDa, (Fig. 3) which meant that water yam flour protein contained dioscorin. The concentration of dioscorin based on all water soluble proteins was 0.252 and 0.141% for non blanched and blanched purple water yam. Meanwhile, non blanched and blanched yellow water yam flour had dioscorin concentration of 0.137 and 0.044% based on all water soluble proteins. Liu *et al*. (2006) reported that dioscorin in *D. alata* has better antioxidant activity than *D. japonica*. Lin *et al*. (2006) also reported dioscorin exsistence in *D. alata* and its antihypertensive activity.

Diosgenin is a steroidal glycoside that has been used in traditional medicine as an anti-hypercholesterolemia, antihypertriacylglycerolemia, anti-diabetes and anti-hyperglycemia (Amir *et al*., 2012). A simple HPLC method was adopted for determination of diosgenin in herbal formulation. The best resolution was achieved using a mobile phase using a mobile phase consisting of acetonitrile: water in the ratio of 90:10 v/v, which gave satisfactory result with sharp well defined and resolved peak with minimum tailing (Warke *et al*., 2011). The retention time of diosgenin was found to be 10-12 min (Fig. 4). The content of diosgenin were 0.0349 and 0.0062 mg/100 g in purple non blanched and blanched water yam flour while yellow non blanched and blanched water yam flour were 0.0293 and 0.0049 mg/100 g. This result is lower than diosgenin yield in *D. zingiberensis* (15 mg/100 g) and *D. deltoidea* (170 mg/100 g) (Li *et al*., 2012; Amir *et al*., 2012). Behera *et al*. (2010) also reported that diosgenin yield of *D. alata* is the lowest among the other *Dfioscorea* species.

Blanching and water yam varieties affect the concentration of bioactive compounds. Blanched water yam had lesser WSNP, dioscorin and diosgenin content, this maybe because of the leaching out during steam

blanching. WSNP and dioscorin were water soluble polysaccharide and protein while diosgenin were hydrolized from saponin that has hydrophilic properties.

CONCLUSION

Blanching at 97±2°C for 7 min affects the flour nutrients and color of water yam flour which is showed by the high value of Lightness (L). Non blanched purple water yam flour has the highest yield. Purple water yam flour has higher moisture content than yellow water yam flour. Swelling power increase along with heating temperature. Non blanched purple water yam flour has the highest foaming ability. Bulk density of yellow and purple water yam flour is about 0.8 g/mL. Blanched yellow water yam flour has the highest WAC and OAC (2.016 g water/g flour and 1.18 g oil/g flour). Water yam flour also contain of bioactive compound such as water soluble polysaccharide (±0.1%), dioscorin (0.044-0.252%) and diosgenin 0.0049-0.0349 mg/100 g). Blanching at 97°C for 7 min and variety of water yam affect the bioactive content.

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