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EFFECTS OF DIFFERENT PROCESSING METHODS ON THE RESISTANT STARCH CONTENT OF SOME LEGUMES

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ABSTRACT

This work describes the effects of different processing methods on resistant starch (RS) contents of *Canavalia ensiformis*, *Detarium microcarpum*, *Jatropha curcas and Glycine max.* meals. The legume seeds were subjected to different processing methods (Raw, soaked, Boiled, Toasted and Fermented). Resistant Starch was determined by Megazyme Resistant Starch Assay procedure (A.O.A.C, 2002). In the results, the highest resistant starch contents were recorded in the toasted method for the three legume meals (*Canavalia ensiformis* 11.69 %, *Detarium microcarpum* 10.49 %, *Jatropha curcas* 13.06 %, while in *Glycine max.* 12.0 % was recorded in the boiled method). The lowest resistant starch contents were recorded in the raw processing method for the three legume meals (*Canavalia ensiformis* 8.47 %, *Detarium microcarpum* 7.25 %, *Jatropha curcas* 9.13 %, while in *Glycine max.* 7.51 % was recorded in the soaked method). The results of this research have proven the type 3 (RS3) resistant starch, which is retrograded starch made by cooking/cooling processes on starchy materials. Data were analyzed using one-way ANOVA and significant differences ($p<0.05$) were recorded among the different processing methods.

Keywords: Resistant Starch, Processing, Retrograded, Legumes and Meals

INTRODUCTION

During food processing, derivatization of nutrients and formation of cross-linkages occur, thereby making the food inaccessible for digestion and metabolism, such parts of nutrients are also "unavailable" (Nor *et al*., 2015). Starch is the major dietary source of carbohydrates is the most abundant storage form of polysaccharide in plants and occurs as granules in the chloroplast of green leaves and the amyloplast of seeds, pulses, and tubers (Ellis *et al*., 1998). The relative recognition of incomplete digestion and absorption of starch in the small intestine as a normal phenomenon has raised interest in non-digestible starch fractions (Cummings and Englyst, 1991; Englyst *et al*., 1992). These are called "resistant starches," and studies have shown them to have physiological functions similar to those of dietary fibre (Asp, 1994; Eerlingen and Delcour, 1995). The diversity of the modern food industry and the enormous variety of food products it produces require starches that can tolerate a wide range of processing techniques and preparation conditions (Visser *et al*., 1997). These demands are met by modifying native starches with chemical, physical, and enzymatic methods (Betancur and Chel, 1997) which may lead to the formation of indigestible residues, such starches therefore, deserve consideration.

Resistant starch is the fraction of starch that is not hydrolyzed to D-glucose in the small intestine within 120 min of being consumed, but which is fermented in the colon (Tharanathan, 2002). Resistant starch refers to the portion of starch and starch products that resist digestion as they pass through the gastrointestinal tract. RS is an extremely broad and diverse range of materials and many different types exist (RS1–4) (Nugent, 2005; Englyst and Cummings, 1987; Englyst *et al*., 1992; Eerlingen and Delcour, 1995; Brown, 1996; Haralampu, 2000).

Many studies suggest that resistant starch (RS) intake decreases postprandial glycaemic and insulinemic responses (Frank *et al*., 2015) lowers plasma cholesterol and triglyceride concentrations, increases satiety and decreases fat storage. Its beneficial effect on human type 2 diabetes has also been proposed. The prevalence of diabetes in Nigeria is expected to grow from 1,707,000 in the year 2000 to 4,835,000 in 2030 (WHO, 2015). RS as a prebiotic can promote the growth of beneficial microorganisms such as bifidobacteria, which exert a lot of beneficial effects on the human body. Butyrate, a short-chain fatty acid (SCFA) produced as a result of fermentation of RS has been hypothesized to reduce the risk of colon cancer and to benefit inflammatory bowel disease (Frank *et al*., 2015). These properties make RS an important functional fiber component of food, which can be exploited in the prevention and management of chronic non-communicable diseases. The nature of RS in foods is variable and is classified based on its botanical source and processing. Resistant starch (RS) is naturally found in starchy foods such as potato, corn and rice and is classified into four subtypes based on its physicochemical properties. Type1 (RS1) is physically unavailable starch. Amylolytic enzymes have no access to starch accumulated in undamaged plant cells as the gastrointestinal tract lacks enzymes capable of degrading the components of plant cell walls. Type 2 (RS2) is native granular starch, such as that found in potato and banana. Type 3 (RS3) is retrograded starch made by cooking/cooling processes on starchy materials occurring in the form of water insoluble semi-crystalline structures. As a result of retrogradation, more thermostable structures are formed by amylose rather than by amylopectin. The amount of resistant starch produced this way increases along with the increasing amylose content of starch. Type 4 (RS4) is chemically modified starch (Frank *et al*., 2015).

MATERIALS AND METHODS

Preparation of the Legume Seeds and Processing

The fruits were cracked open mechanically to remove the seeds. The seeds were dehulled, clean of debris by handpicking and winnowed. The seeds size were reduced with pestle and mortar and subjected to various processing methods according to Doss *et al*. (2011) and Antyev (2018) methods

i. Raw seeds were milled and tag raw seed meal (RSM)
ii. Raw seeds were soaked in water to the ratio of 1:3 for 72hours, oven-dried at 50ºC to constant weight then milled and tag soaked seed meal (SSM)
iii. Raw seeds were boiled for 30minutes, oven-dried at 50ºC to constant weight then milled and tag boiled seed meal (BSM)
iv. Raw seeds were toasted at 70ºC using an electric hot plate until seeds turn brown in colour then milled and tag Toasted seed meal (TSM)
v. Raw seeds were moistened with water, kept in a container with a cover to ferment for 72 hours under laboratory condition, oven-dried at 50ºC then milled and tag fermented seed meal (FSM)

Measurement of Resistant Starch Content

Resistant starch was determined by Megazyme Resistant Starch Assay procedure (AOAC Method 2002). Boiled and homogenized samples were incubated with 10 mL of HCl–KCl buffer (pH 1.5) and 20mg pepsin for 1 hour at 37 °C, then, samples were incubated with pancreatic a-amylase (10 mg/mL) solution containing amyloglucosidase (AMG) for 16 hours at 37 °C with constant shaking for starch hydrolysis. After hydrolysis, samples were washed thrice with ethanol (99% v/v and 50% ethanol). The separated pellet from the supernatant was further digested with 2 M KOH. The supernatant was discarded and the digested pellet incubated with AMG. Glucose released was measured using a glucose oxidase–peroxidase kit, Megazyme. The absorbance was measured with a spectrophotometer (Jenway 6405, UK) at 510 nm wavelength against the reagent blank. The glucose content of the digested pellet was used in the calculation of resistant starch **(RS),** by applying the factor of 0.9.

RESULT AND DISCUSSION

The results of raw and different processed legume seed meals on the Resistant Starch compositions, shown in Table 1. The one-way ANOVA test performed showed that the different treatments indicated significant differences (p<0.05) in resistant starch compositions.

Table 1: Resistant Starch Content of raw and Processed *Canavalia ensiformis*, *Detarium microcarpum*, *Jatropha curcas* and *Glycine max* Meals (mg-100g)

Samples	Raw	Boiled	Toasted	Soaked	Fermented
Canavalia ensiformis	8.47 ± 0.01^c	10.9 ± 0.01^b	11.69 ± 0.01^a	8.79 ± 0.01^c	10.63 ± 0.01^b
Detarium microcarpum	7.25 ± 0.00^d	9.79 ± 0.01^b	10.49 ± 0.01^a	8.12 ± 0.01^c	9.24 ± 0.00^b
Jatropha curcas	9.13 ± 0.01^d	10.22 ± 0.00^c	13.06 ± 0.01^a	9.85 ± 0.00^d	12.44 ± 0.00^b
Glycine max	11.1 ± 0.01^b	12.0 ± 0.001^a	10.34 ± 0.01^c	7.51 ± 0.01^e	9.50 ± 0.01^d

Mean±Std on the same row with different superscripts are significantly different (P<0.05)

Bezerra *et al*. (2013) reported that resistant starch content may be modified by some types of processing and this agrees with the result of my studies, Resistant Starch content in foods is influenced by intrinsic and extrinsic factors as well as processing techniques (Frank *et al*., 2015). The results are shown in Table 1 and processing increased the resistant starch contents of the three underutilized legume seed meals. When the different processing methods were compared in *C. ensiformis*, *D. microcarpum*, and *J. curcas* meals, toasting increases the resistant starch contents. The resistant starch results in this study is lower than that reported by Bezerra *et al*. (2013) for peeled and unpeeled green banana flour respectively; Polesi *et al*. (2011) for pea and chickpea (39.85% and 31.87%); Moongngarm (2013) for some starchy foods and Moongngarm *et al*. (2014) for unripe banana flour. Similar trends were reported by Nor *et al*. (2015) for different formulation samples cooked at 100°C. The repeated cooking and chilling processes facilitate further gelatinization and retrogradation of the fish crackers, thus promoting the formation of resistant starch. The result of resistant starch content reported by Frank *et al*. (2015) on the resistant starch content of some cassava-based Nigerian foods was lower than the values recorded in this work

CONCLUSION

From the experiment, it is apparent that different processing methods alter the resistant starch contents of the seed meals

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REFERENCES

Antyev, M. (2018). Nutritive evaluation of *Jatropha curcas* seed meal in poultry production. Ph.D Thesis, Modibbo Adama University of Technology Yola, Pp 79-95. Unpublished.

AOAC. (2002.02). Official Method of Analyzing Resistant Starch in Plant Materials Enzymatic Digestion First Action 2002.

Asp, N. G. (1994). Nutritional classification of food carbohydrates. *America Journal of Clinical Nutrition* 59:679–81.

Betancur, A. D. and Chel, G. L. (1997). Acid hydrolysis and characterization of *Canavalia ensiformis* starch. *Journal of Agriculture and Food Chemistry*, 45:4237–41.

Bezerra, C.V., Da Cruiz Rodrigues, A.M., Amante, E.R. and Da Silva, L.H.M. (2013). Nutritional potential of green banana flour obtained by drying in spouted bed. *Revista Brasileira de Fructicultura*, 35:4, 121-130.

Brown, I. (1996). Complex carbohydrates and resistant starch. *Nutrition Revision*, 54:115–119.

Cummings, J. H. and Englyst, H. N. (1991). Measurement of starch fermentation in the human large intestine. *Canada Journal of Physiological Pharmacology*, 69:121–9.

Doss, A., Pugalenthi, M., Vadivel, V. G., Subhashini, G. and Anitha Subash, R. (2011). Effects of processing technique on the nutritional composition and antinutrients content of under – utilized food legume *Canavalia ensiformis* L.DC. *International Food Research Journal 18(3): 965-970.*

Eerlingen, R.C. and Delcour, A. (1995) Formation, analysis, structure and properties of type III enzyme resistant starch. *Journal of Cereal Science* 22, 129–138.

Ellis, R. P., Cochrane, M. P., Dale, M. F. B., Duffus, C. M., Lynn, A., Morrison, I. M., Prentice, R. D. M., Swanston, J. S. and Tiller, S. A. (1998). Starch production and industrial use. *Journal of Science Food and Agriculture,* 77:289–311.

Englyst, H.N., Kingman, S.M. and Cummings, J.H. (1992). Classification and measurement of nutritionally important starch fractions. *European Journal of Clinical Nutrition*. 46 (Supplement 2), 33–50.

Englyst, H. N. and Cummings, J.H. (1987). Digestion of polysaccharides of potato in the small intestine of man. *American Journal of Clinical Nutrition* 45, 423–431.

Frank C. O. and Edith, N.O. (2015). The resistant starch content of some cassava based Nigerian foods. *Nigerian food Journal*, 33: 29-34

Haralampu, S.G. (2000). Resistant starch – a review of the physical properties and biological impact of RS3. *Carbohydrate Polymers*, 41:285–292.

Jagannadhan, K., Parimalavalli, R. and Surendra Babu, A. (2017). Effect of triple retrogradation treatment on chickpea resistant starch formation and its characterization. *Journal of food science and Technology*, 54(4): 901-908.

Moongngarm A. (2013). Chemical compositions and Resistant starch content in starch foods. Amaerican *Journal of Agriculture and Biological sciences*, 8(2): 107-113.

Moongngarm, A., Tiboonbun, W., Sampong, M., Sriwong, P., Phiewtong, L., Prakitrum, R. and Huychan, N. (2014). Resistant starch and bioactive contents of unripe banana flour as influenced by harvesting periods and its application. *American Journal of Agricultural and Biological Sciences*, 9(3): 457-465.

Nor, M. Z. M.., Talib, R. A., Noranizan, M. A., Chin, N. L. and Hashim, K. (2015) Effects of Cooking Temperature in Repetitive Cooking-Chilling Cycles on Resistant Starch Content and Quality Characteristics of Fish Crackers. *Pertanika Journal of Science and Technology*, 23 (2): 311 – 323.

Nugent, A. (2005). Health properties of resistant starch. Britain Nutrition Foundation. *Nutrition Bullten,* 30, 27-54.

Polesi, L.F., Sarmento, S. B. S. and Dos Anjos, C.B.P. (2011). Composition and Characterization of pea and chickpea starches. *Braizilian Journal of food Technology*, 14(1): 74-81.

Tharanathan, R. N. (2002). Food-derived carbohydrates: Structural complexity and functional diversity. *Critical Reviews in Biotechnology*, 22(1), 65–84.

Visser, R. G. F., Suurs, L. C. J. M., Bruinenberg, P. M., Bleeker, I. and Jacobsen, E. (1997). Comparison between amylose-free and amylose containing potato starches. *Starch/Stärke* 49:438–43.

WHO. (2015). Country and regional data on diabetes. ⟨http://www.who.int/ diabetes/facts/world figures/en/index1.html⟩ (accessed10.12.14).