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

*Michael, K. G., Sogbesan, O. A. and Onyia, I. U.

Department of Fisheries, Modibbo Adama University of Technology Yola P.M.B. 2076, Adamawa State Nigeria.

*Corresponding Author’s email: keccybaby1258@gmail.com +23408063692508

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 boiled 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 insulimetic 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. Type 1 (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 amylase rather than by amylopectin. The amount of resistant starch produced this way increases along with the increasing amylase 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 50°C to constant weight then milled and tag soaked seed meal (SSM)
iii. Raw seeds were boiled for 30minutes, oven-dried at 50°C to constant weight then milled and tag boiled seed meal (BSM)
iv. Raw seeds were toasted at 70°C 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 50°C 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 α-amylase (10 mg/mL) solution containing amylglucosidase (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)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Raw</th>
<th>Boiled</th>
<th>Toasted</th>
<th>Soaked</th>
<th>Fermented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canavalia ensiformis</td>
<td>8.47±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>10.9±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11.69±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.79±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>10.63±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Detarium microcarpum</td>
<td>7.25±0.00&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9.79±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.49±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.12±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.24±0.00&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Jatropha curcas</td>
<td>9.13±0.01&lt;sup&gt;d&lt;/sup&gt;</td>
<td>10.22±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13.06±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.85±0.00&lt;sup&gt;d&lt;/sup&gt;</td>
<td>12.44±0.00&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Glycine max</td>
<td>11.1±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.0±0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.34±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.51±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.50±0.01&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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.

ACKNOWLEDGEMENTS
The authors would like to thank Modibbo Adama University of Technology Yola, for providing financial support.

REFERENCES


Pertanika Journal of Science and Technology, 23 (2): 311 – 323.


