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RESEARCH NOTE

Effect of Indigenous Processing on the Nutrient and Antinutrient Content of Corn (*Zea mays* L.)

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Antinutrients are metabolites that can decrease the bioavailability of nutrients in food, but they can be reduced by certain processing methods. The Obu Manuvu group in Marilog District, Davao City practices indigenous processing of corn. Analyses of the antinutrient content showed a significant decrease in cyanogenic glycoside and tannin. These changes profoundly affected the proximate composition and mineral content of corn. The total carbohydrate, zinc, manganese, and calcium content increased while moisture, crude fat, and crude fiber content decreased after processing. Hence, the indigenous processing of corn by the Obu Manuvu represents a good practice in improving the nutritional profile of corn in terms of greater availability of some nutrients.

Keywords: antinutrient, corn, indigenous processing, nutrient, roasting, size reduction

INTRODUCTION

Antinutrients are secondary metabolites synthesized naturally by plants as defense mechanism against herbivorous and pathogenic organisms, as well as adverse growing conditions (Bora 2014). One major concern about antinutrients is their binding ability with nutrients. Hence, these compounds can potentially reduce the availability of nutrients especially proteins, vitamins, and minerals, thereby limiting their maximum utilization in the body (Gemede and Ratta 2014). However, studies have shown that several traditional food processing methods can be employed to reduce or remove these antinutrients (Bora 2014).

The Obu Manuvu – an indigenous group in Marilog District, Davao City – practices indigenous processing of corn to make *binukbok nga batad*, a popular snack for kids and adults. It is interesting to study the effect of this indigenous processing on the nutritional profile of corn as it can affect the overall health status of the said community. Results of this study can be used as baseline data in assessing the suitability of the processing method in terms of improvement of the nutrient content of corn.

The general objective of this study was to determine the effect of indigenous processing on the nutrient and antinutrient content of corn. Specifically, this study aimed to determine the antinutrient content (cyanogenic glycoside, tannin, and oxalate); proximate composition; and mineral content (iron, zinc, manganese, calcium, and copper) of raw and processed corn samples.

The corn sample used in this study was collected from Barangay Magsaysay in Marilog District, Davao City. Portion of the sample was processed by the tribal cooks of Obu Manuvu based on their tradition. Antinutrient analyses were carried out using alkaline picrate method for cyanogenic glycoside (Eleazu and Eleazu 2012), Folin-Ciocalteu Assay for tannin (Mohammed and Manan 2015),

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and permanganimetric titration for oxalate (Hailu and Addis 2016). Proximate analysis was done using official methods of the Association of Official Analytical Chemists (AOAC Methods 1985). Minerals such as copper, calcium, zinc, and manganese were analysed through atomic absorption spectrophotometry (AAS) while iron was determined by UV-Vis spectrophotometry. All analyses were carried out using three trials. Independent t-test was then used to determine significant differences between values obtained for raw and processed samples.

RESULTS AND DISCUSSION

Figure 1 shows the indigenous processing of corn as done by the Obu Manuvu Group to make *binukbok nga batad*. The process was observed to involve two important parts: roasting and size reduction. The effects of the entire processing method on the nutritional quality of corn were further evaluated in this study.

Table 1 shows the effect of indigenous processing on the antinutrient content of corn. A significant decrease in cyanogenic glycoside was observed after processing ($p \leq 0.05$). When the particle size of the sample is smaller, cyanogenic glycoside (mainly linamarin) has closer contact with the hydrolyzing enzyme linamarase. This promotes faster breakdown of linamarin to hydrogen cyanide (HCN), which is volatile and readily dissipates when heat is applied (Hill 2003, Cardoso *et al.* 2005, Ivanov *et al.* 2012). Since the indigenous processing done by the Obu Manuvu on corn involved roasting and size reduction, these steps may have caused the significant decrease in the cyanogenic glycoside content of the processed corn.

Table 1. Effect of indigenous processing on the antinutrient content of corn.

Parameter	Raw Corn	Processed Corn
Cyanogenic glycoside, %	0.11 ± 0.01^{a}	0.07 ± 0.00^{b}
Tannin, %	0.26 ± 0.01^{a}	0.12 ± 0.03^{b}
Oxalate, %	0.98 ± 0.20^{b}	4.96 ± 0.05^{a}

Note: Values with different superscripts indicate significant difference at α = 0.05 level of significance.

The tannin content of corn also significantly decreased after processing. The observed decrease in tannin can be attributed to the combined effects of roasting in open air (Makkar and Becker 1996, Rakić *et al.* 2004)

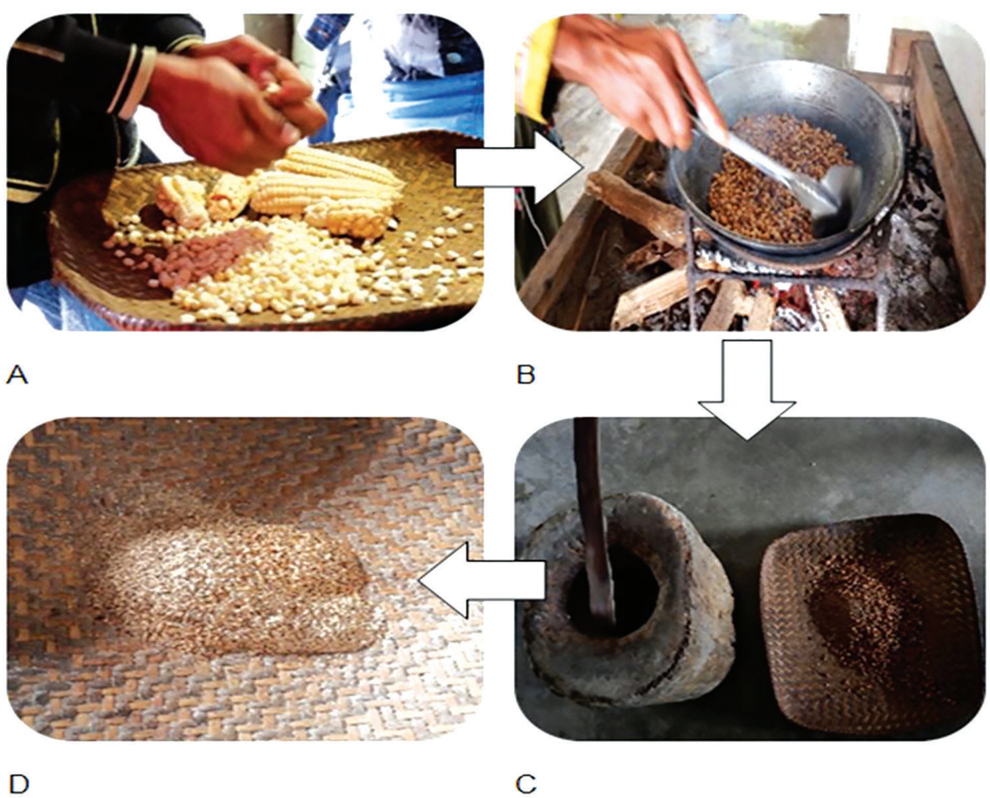

Figure 1. Sequential processing of corn to make *binukbok nga batad*: (A) removal of corn kernels (lobo), (B) roasting of corn kernels (*sangag*), (C) pounding of corn kernels using *bayo* (*lobok*), (D) winnowing of pounded corn kernels using *nigo* (*taphan*).

and mechanical damage through pounding of the corn kernels as tannins are mostly located on the outer layer of the kernels (Nikmaram *et al.* 2017).

The oxalate content of corn significantly increased after processing ($p \leq 0.05$). The roasting step may have concentrated the oxalate content due to moisture loss. The lethal dose of oxalate for humans is 15–30 g (Silberhorn 2005). Based on the obtained percentage of oxalate in processed corn, consumption of 100 g allows the intake of 4.96 g oxalate, which is still within the tolerable dose.

Results of the proximate analyses done on corn are shown in Table 2. The moisture content significantly decreased after processing ($p \leq 0.05$) primarily because of heat application. The crude fat content also decreased in the processed sample ($p \leq 0.05$). According to Adegunwa *et al.* (2012), during heating, cell structures and membranes are disrupted causing the fat to melt and be easily released from the grain. The crude fiber content also significantly decreased ($p \leq 0.05$) after processing. This may be due to structural alteration of the cell wall as a result of high temperature, which led to the breakage of weak bonds between polysaccharide chains and glycosidic linkages in the fiber (Oboh *et al.* 2010). Furthermore, the pounding step may have contributed as well to the decrease in fiber. The fiber in corn is concentrated in the seed coat or pericarp; hence, the loss may be attributed to the removal of the chaff during pounding of the kernels.

It is also shown in Table 2 that the total carbohydrate content of corn increased after processing. The increase in carbohydrates may be attributed to the decrease in tannin, as tannins are known to form complexes with the former (Gemede and Ratta 2014). Low level of tannin in processed corn means that more carbohydrates are available.

No significant differences were observed between raw and processed samples for the crude ash and crude protein content. A comparison of the changes in the proximate composition of corn as obtained by various authors before and after processing is shown in Table 3.

Table 4 shows the effect of indigenous processing on the mineral content of corn. The amount of iron did not significantly change. The Recommended Dietary Allowance (RDA) for iron is 7–11 mg for children (ODS 2010). Based on the result obtained for the iron content of processed corn, consumption of 100 g imparts 32.9 mg iron. Thus, *binukbok nga batad* is a good source of iron that allows one to meet the RDA.

Other minerals in corn such as zinc, manganese and calcium significantly increased after indigenous processing ($p \leq 0.05$). This may be attributed to the observed decrease in tannin after processing. Tannin forms chelate with zinc, manganese, and calcium – making them less available (Beecher 2003, Keen and

Table 2. Effect of indigenous processing on the proximate composition of corn.

Parameter	Raw Corn	Processed Corn
Moisture, %	33.57 ± 0.34^a	7.19 ± 0.11^b
Fat, %	13.34 ± 0.46^a	9.19 ± 0.43^b
Fiber, %	1.82 ± 0.34^a	0.96 ± 0.16^b
Ash, %	1.07 ± 0.25^a	0.77 ± 0.28^a
Protein, %	8.70 ± 1.08^a	8.09 ± 0.66^a
Carbohydrates, %	41.51	73.93

Note: Values with different superscripts indicate significant difference at $\alpha = 0.05$ level of significance.

Table 4. Effect of indigenous processing on the mineral content of corn.

Parameter	Raw Corn	Processed Corn
Iron, ppm	287.25 ± 61.69^a	329.14 ± 65.75^a
Zinc, ppm	5.5 ± 0.07^b	6.25 ± 0.07^a
Manganese, ppm	7.45 ± 0.35^b	9.75 ± 0.21^a
Calcium, ppm	34.30 ± 3.82^b	95.25 ± 1.34^a

Note: Values with different superscripts indicate significant difference at α = 0.05 level of significance

Table 3. Proximate composition of raw and roasted corn as reported in various literatures.

Proximate Composition, (%)	Ayatse *et al.* (1983)		Kavitha and Parimalavalli (2014)		Oboh *et al.* (2010)		This study	
	Raw	Roasted	Raw	Roasted	Raw	Roasted	Raw	Roasted
Moisture	12.54 ± 1.74	7.24 ± 1.11	7.60 ± 0.83	7.06 ± 0.94	16.92 ± 2.0	14.31 ± 1.2	33.57 ± 0.34	7.19 ± 0.11
Ash	1.39 ± 0.08	1.35 ± 0.14	1.34 ± 0.16	1.19 ± 0.54	1.93 ± 0.7	2.00 ± 0.1	1.07 ± 0.25	0.77 ± 0.28
Fat	4.34 ± 0.27	4.60 ± 0.18	4.36 ± 0.36	5.09 ± 0.37	5.32 ± 1.2	6.39 ± 0.9	13.34 ± 0.46	9.19 ± 0.43
Protein	9.10 ± 0.20	9.22 ± 0.20	5.64 ± 0.15	4.24 ± 0.17	12.97 ± 2.1	10.86 ± 1.6	8.7 ± 1.08	8.09 ± 0.66
Fiber	1.42 ± 0.06	1.36 ± 0.04	1.54 ± 0.26	0.84 ± 0.04	1.32 ± 0.2	1.24 ± 0.2	1.82 ± 0.34	0.96 ± 0.16
Carbohydrates	72.63 ± 2.00	76.23 ± 4.10	97.60 ± 4.83	87.06 ± 5.94	61.54 ± 1.9	65.20 ± 3.0	41.51	73.93

Zidenberg-Cherr 2003, Lestienne *et al.* 2005). Hence, the pronounced decrease in tannin positively affected the levels of these minerals. It must be noted though that the amount of these minerals in processed corn still do not suffice to meet the RDA. In addition, copper was not detected in raw and processed corn samples. Hence, alternative sources of zinc, manganese, calcium, and copper must also be considered by the Obu Manuvu community.

It is recommended to analyze other nutrients and antinutrients in corn for a more in-depth evaluation of the effect of the indigenous processing of the Obu Manuvu on the overall nutritional quality of corn.

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