EFFECT OF PROCESSING ON THE PHYTOCHEMICAL COMPOSITION OF AMARANTH GRAIN (*Amaranthus cruentus* Linnaeus)

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ABSTRACT
A study was conducted to evaluate the effect of different processing methods on the qualitative and quantitative phytochemical composition of Amaranth grain (Amaranthus cruentus L.). The processing methods included fermentation, roasting and sprouting. Phytochemical compounds such as saponins, alkaloids, phenolics, flavonoids, phytates, and oxalates were assessed. The results indicated a heavy presence of alkaloids in raw and sprouted grains, while fermented and roasted grains exhibited moderate levels. All processed grains showed a moderate presence of phytates, whereas tannins were absent across all treatments. Phenol was present in raw and fermented grains but however absent in sprouted and roasted samples. Quantitative analysis revealed that raw amaranth grain had the highest alkaloid content (6.94 g/100g), followed by sprouted grains (4.70 g/100g Amaranthus cruentus). Flavonoid content was highest in roasted (6.03 g/100g) grains while the least was observed in fermented and raw amaranth grain with (2.70 g/100g, 2.88 g/100g respectively). The findings suggest that processing methods can modify the phytochemical composition of amaranth grain, enhancing its nutritional potential while reducing anti-nutritional factors making it a viable non- conventional feed ingredient in poultry production.
Keywords: Amaranth grain, Phytochemicals, Processing methods, Anti-nutritional factors

INTRODUCTION

The increasing cost and competition for conventional grain feedstuff like maize in animal nutrition have necessitated the search for alternative feed ingredients. Amaranth grain (*Amaranthus cruentus*), an underutilised pseudo-cereal, has gained attention due to its high nutritional value, drought resistance, and rapid growth cycle (Jamalluddin *et al.,* 2021). *Amaranthus cruentus* grain contains a well-balanced amino acid profile, particularly high in the second most - limiting amino acid in poultry (lysine) levels, making it a promising substitute for conventional protein and energy sources in monogastric animal diets. However, the presence of anti-nutritional factors such as saponins, tannins, phenolics, and oxalates may limit its utilisation in animal feed, affecting digestibility and nutrient bioavailability (Venskutonis and Kraujalis, 2013).

Processing techniques such as fermentation, roasting, and extrusion have been employed to enhance nutrient availability and reduce anti-nutritional compounds in various feed ingredients (Amare *et al*. 2015), fermentation is known to improve protein digestibility and eliminate certain anti-nutritional factors, while roasting and extrusion help break down complex compounds, improving the bioavailability of essential nutrients (Ali *et al*., 2009; Shinde *et al*., 2020). The use of appropriate processing methods can significantly alter the qualitative and quantitative phytochemical composition of feed ingredients, thereby improving their nutritional composition for poultry and other monogastric animals.

Despite the potential benefits of amaranth grain, there is limited scientific information on how different processing methods affect its phytochemical composition. Understanding the impact of these processing techniques on the retention or reduction of bioactive compounds such as saponins, alkaloids, phenolics, and flavonoids is crucial for optimizing its use in animal diets. This study was aimed at evaluating the effect of fermentation, roasting and sprouting on the qualitative and quantitative phytochemical composition of amaranth grain, with the goal of determining the most effective processing method to improve its nutritional value while minimizing anti-nutritional factors. The aim of this research was to provide valuable insights into the potential of processed amaranth grain as a viable alternative feed ingredient in monogastric animal nutrition.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the Department of Animal Production, Federal College of Agriculture, Moor Plantation, Ibadan, Oyo State, Nigeria. The qualitative and quantitative phytochemical composition of differently processed amaranth grain (*Amaranthus cruentus*) was carried out by methods described by AOAC (2005) at the Biochemical Laboratory of the Institute of Agriculture and Research Training (IAR&T).

Collection and Processing of Amaranth Grain

Raw amaranth grain was sourced from a local farmer in Ibadan. The grain was cleaned by winnowing to remove foreign materials before being subjected to four processing methods:

Raw: Cleaned amaranth grains were ground into powder without any treatment.
Fermented: The grains were soaked in water for 72 hours, sun-dried, and ground into fine powder (Ali *et al.,* 2009).

Sprouted: The grain was rinsed and soaked in distilled water (seeds to water ratio 300g/L) for 5 hours at room temperature. To keep the moisture consistent, the seeds were placed over a damp jute sack and covered for 48 hours at room temperature. The germinated seeds were air dried for 48 hours (Compensates de Ruiz and Bressani, 1990).

Roasted: The grains were roasted in an oven at 127°C for 5–6 minutes, cooled, and ground (Njoki, 2014).

Experimental Design

The experiment followed a Completely Randomized Design (CRD) with four treatments representing different processing methods:

T1: Raw amaranth grain (control) **T2:** Fermented amaranth grain
T3: Sprouted amaranth grain **T4:** Roasted amaranth grain

Data Collection

Phytochemical Analysis

Both qualitative and quantitative analyses of phytochemicals were conducted on all processed amaranth grain samples. The presence of saponins, alkaloids, total phenolics, flavonoids, phytates, oxalates, and tannins was determined using AOAC Protocol (AOAC, 2000).

Statistical Analysis

The experimental design was a Completely Randomized Design (CRD). Data were subjected to one-way Analysis of Variance (ANOVA) using SAS (1999), and means were separated using Duncan's Multiple Range Test at a significance level of $P<0.05$.

RESULTS AND DISCUSSION

The qualitative phytochemical composition of amaranth grain under different processing methods is presented in Table 1. Alkaloids were significantly present in raw and sprouted grains but reduced in fermented and roasted samples. Phytates were moderately present in all samples, while tannins were absent in all treatments (Becker *et al*., 2001).

Qualitative Analysis

Phytochemical screening was performed to determine the presence or absence of key bioactive compounds. Observations were categorized as heavily present (+++), moderately present (++), slightly present (+), or absent (-).

Table 1: Qualitative Phytochemical Composition of Processed Amaranth Grain

Treatment	Saponin	Alkaloid	Total Phenolics	Phytate	Tannin
Raw AG	+	+++	+	+	-
Fermented AG	+	+	+	+	-
Sprouted AG	-	++	-	+	-
Roasted AG	+	+	-	+	-

AG- Amaranth grain

Quantitative Analysis

The concentration of each phytochemical compound was measured in grams per 100 grams (g/100g).
Table 2 shows the quantitative phytochemical composition, where raw amaranth had the highest alkaloid content (6.94 g/100g), followed by sprouted grains (4.70 g/100g). Flavonoid content was most concentrated in roasted

(6.03 g/100g) grains. The result of this study showed that phytate content was least in sprouted (3.76 g/100g) and roasted amaranth grain (3.59 g/100g) compared to other processing methods. The reason for the reduction of phytate in sprouted amaranth grain could be because during sprouting, phytase is activated which hydrolyse phytic acid into inositol and free phosphate, thereby enhancing mineral bioavailability (Njoki, 2014). Sprouting enhanced total phenolic and flavonoid content of amaranth grain improves antioxidant property of Amaranth grain this could be due to the induction of the activity of enzymes like chalcone synthase, which is involved in the biosynthesis of flavonoids. The formation of chalcones and their isomerization into naringenin, a precursor for various flavonoids, increasing the phenolic content in the sprouted Amaranth grain (Colmenares de Ruiz and Bressani, 1990). These findings align with previous studies, indicating that processing methods can effectively reduce anti-nutritional factors while preserving beneficial phytochemicals.

Table 2: Quantitative Phytochemical Composition of Processed Amaranth Grain

Phytochemical	Raw AG	Sprouted AG	Roasted AG	Fermented AG	±SEM
Saponin (g/100g)	0.90[a]	0.20[c]	0.65[ab]	0.70[ab]	0.02
Alkaloid (g/100g)	6.94[a]	4.70[b]	3.40[d]	4.30[c]	0.03
Total Pheno (mgGAE/kg)	0.18[c]	2.40[a]	0.00[d]	1.32[b]	0.01
Flavonoid (g/100g)	2.70[b]	4.32[a]	4.03[a]	2.88[b]	0.02
Phytate (g/100g)	5.10[a]	3.76[c]	3.59[c]	4.46[b]	0.04
Oxalate (mg/g)	6.03[a]	4.32[b]	2.7[c]	2.88[c]	0.02

CONCLUSION

This study demonstrated that processing methods significantly influence the phytochemical composition of amaranth grain. Raw and sprouted grains had the highest alkaloid content, whereas fermentation, roasting, and sprouting reduced anti-nutritional compounds. The results suggest that processing techniques can enhance the nutritional value of amaranth grain for use in monogastric animal nutrition.

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