METHIONINE AND LYSINE PROFILE OF TUBER AND PRODUCTS OF CASSAVA (*MANIHOT ESCULENTA* CRANTZ) VARIETIES

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ABSTRACT
The essential amino acids content of cassava and its products were assessed in this study. A year-old cassava varieties; TMS 01/1412, TMS 01/1371, TMS 01/1368, TMS 07/0593 and TME 419, were harvested and processed. The products were; fresh peeled tuber, garri, garri flour, grit, grit flour, peelings, peels and leaves. The products were analysed for both methionine and lysine and ensuing data were subjected to descriptive statistics and ANOVA at $\alpha_{0.05}$. *Results showed that both amino acids (AA) were present in the analysed cassava tuber and products. Cassava leaves had the highest concentration (4.31-5.20 g/kg methionine and ii.15-14.86 g/kg lysine) of both AA (p<0.05) among the products analysed. However, cassava variety TMS 01/1412 consistently had higher (p<0.05) concentrations of both AA compared to other varieties. Thus, cassava and its by-products contained sizable content of high-quality AA desirable in animal feeding if properly processed.*
Keywords: Cassava products, Limiting amino acid, Methionine, Lysine

INTRODUCTION

Cassava and its products are one of the most consumed condiments by humans and animal with prominent consumption in Africa, over one billion people were reported to consume cassava in different forms worldwide (Ogunwole et al., 2015; Adebayo, 2023). Rice, wheat and maize are the only staple food considered to be more important than cassava globally, while cassava is rated as the second most important food crop in sub-Saharan Africa (Katz and Weaver, 2020).

Amino acids (AA) are essential components of human and animal nutrition (Karau and Grayson, 2014). Every plant and animal product has their respective protein content and inherent amino acid composition, which may be complete or incomplete. The two first limiting AA are increasingly being used as dietary supplements for human and livestock feeding with reported side effects (Holecek, 2022). Hence, understanding dietary concentration of AA in food and feed ingredients have become imperative. Unfortunately, the amino acids content of most locally produced food products including bio-fortified cassava are unknown.

The erstwhile paucity of information on the first two limiting AA of most locally produced food products makes it challenging for nutritionists to evaluate and investigate the dietary and metabolic demand and pathways (Yeoh, 1996; Ford et al. 2023). Reports on chemical profile of cassava products, particularly, on amino acid profile, in the past decades are relatively less copious (Nassar et al., 2009; Ravindran, 1991; Yeoh, 1996; Ravindran, 2013), than in the last decade (Morgan and Coct, 2016; Ogunwole et al., 2017; Omode et al., 2018; Zekarias et al., 2019; Oloruntola, 2020; Abioye, 2022; Adebayo, 2023). Most documentations were on gross AA profile without emphases on the first two nutritionally limiting AA in the processed products of the different cassava varieties, which now is the objective of this investigation.

MATERIALS AND METHODS

Experimental Site

This experiment was carried out at the Research and Demonstration Farm of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria on latitude 7.501424º E and longitude 3.90992º N coordinate. The chemical analyses were carried out at the Department of Animal Science Laboratories, University of Ibadan, Ibadan, Nigeria on latitude 7.4506º E and longitude 3.8951º N coordinate.

Test Materials

Five cassava varieties, TMS 01/1412, TMS 01/1371, TMS 01/1368, TMS 07/0593 and TME 419 (conventional white variety in Nigeria), aged 12 months were obtained from the International Institute of Tropical Agriculture, Ibadan, Nigeria. Fresh tubers and leaves were processed into fresh peeled tuber, garri, garri flour, grit, grit flour, peelings, peels and leaves.

Preparation of Test Materials
Details of the preparation and processing of the different cassava varieties have been documented (Ogunwole et al., 2017)

Methionine and Lysine Determination

The methionine and lysine determination was by the method of EN ISO 13903:2005 documented by Dalibard et al. (2014) as modified. Methionine and lysine were isolated from the cassava products using 0.1 mol/l hydrochloric acid for extraction. Any co-extracted nitrogenous macromolecules were precipitated using sulfosalicylic acid and subsequently removed via filtration. Following which, the solution undergoes filtration and adjusted to pH 2.2. Methionine and lysine were then separated using ion-exchange resins and quantified through photometric detection at 570 nm after reacting with ninhydrin, mirroring the process used for total amino acid determination.

Statistical Analysis
Data were subjected to descriptive statistics and analysis of variance using the procedure of SAS (2002) and means were separated at $\alpha_{0.05}$ using Duncan's multiple range test option of the same software.

RESULTS AND DISCUSSION
The methionine content (g/kg) of tuber and products from five varieties of cassava is presented in Table 3.1. The methionine of tuber and products of the five cassava varieties were significantly different ($p<0.05$). Methionine of Freshly Peeled Tuber from TMS 01/1371 (0.15 g/kg) and TMS 01/1368 (0.15 g/kg) were similar ($p>0.05$) with higher methionine contents. The TMS 01/1412 had higher ($p<0.05$) methionine content for garri, compared to those recorded for TMS 01/1371 (0.1g/kg), TMS 01/1368 (0.09 g/kg), TMS 07/0593 (0.09 g/kg) and TME 419 (0.90 g/kg) which were ($p>0.05$) similar. The TMS 01/1371 (0.1 g/kg) had highest methionine content for garri flour. However, methionine of TMS 01/1412 (0.08 g/kg), TMS 01/1371 (0.08 g/kg) and TME 07/0593 (0.08 g/kg) were not significantly different ($p<0.05$). The TMS 07/0593 garri flour had significantly lower ($p<0.05$) methionine content of 0.070 g/kg. The TMS 01/1371 contained 0.1g/kg methionine which was significantly lower ($p< 0.05$) than 0.07g/kg in TMS 07/0593, Hence, garri oven dried; TMS 01/1412 (0.08 g/kg), TMS 01/1371 (0.10 g/kg), TMS 01/1368 (0.08 g/kg) and TME 07/0593 (0.08 g/kg) all had similar levels ($p>0.05$) of methionine.

Grits from TMS 01/1412 with 0.24 g/kg methionine was the highest, while, the least was recorded for Grit from TMS 01/1368 (0.15 g/Kg). The grit flour, TMS 01/1412 (0.23 g/kg) and TMS 01/1371 (0.23 g/kg) were significantly ($p<0.05$) similar methionine. The methionine for the grit flour were different from values recorded for TMS 01/1368 (0.15g/kg), TMS 07/0593 (0.13g/kg) and TME 419 (0.09g/kg). TME 419 had the least methionine content in grit flour.

The TME 419 had relatively higher ($p<0.05$) methionine content in the peelings (0.58g/kg), similarly, the Leaves of TMS 01/1412 had the highest methionine (0.52g/kg). TMS 01/1371 (0.32g/kg) had the least methionine content in the peelings and leaves (4.31 g/kg). Leaves obtained from TMS 01/1412 (5.20g/Kg) and TME 419 (5.13 g/kg similarly ($p>0.05$) but they both contained highest levels of methionine.

Methionine is an essential sulfur-amino acid, required in the detoxification of cyanide to thiocyanate (Oloruntola, 2020). It is also considered to be the first limiting amino acid in a typical ration of ruminants and poultry. The high methionine for garri, Garri flour, grit, grit flour and leaves from cassava varieties TMS 01/1412 is a potential advantage for performance in livestock as it contains higher level of methionine. Aside from the leaves, the peels had higher methionine content compared to other products from the cassava tuber.

Table 1: Methionine content (g/kg) of tuber and products from five cassava varieties

Product	TMS 01/1412	TMS 01/1371	TMS 01/1368	TMS 07/0593	TME 419	SEM
Freshly peeled tuber	0.14^{b}	0.150^{a}	0.150^{a}	0.12^{d}	0.130^{c}	0.03
Garri	0.12^{a}	0.10^{b}	0.09^{b}	0.090^{b}	0.09^{b}	0.0034
Garri flour	0.08^{ab}	0.10^{a}	0.08^{ab}	0.07^{b}	0.08^{ab}	0.0037
Grit	0.24^{a}	0.23^{b}	0.150^{e}	0.20^{c}	0.17^{d}	0.009
Grit flour	0.23^{a}	0.23^{a}	0.15^{b}	0.13^{c}	0.09^{d}	0.02
Peelings	0.55^{b}	0.32^{e}	0.48^{d}	0.51^{c}	0.58^{a}	0.02
Peels	0.58^{c}	0.40^{e}	0.51^{d}	0.69^{a}	0.59^{b}	0.03
Leaves	5.20^{a}	4.31^{d}	4.50^{c}	4.85^{b}	5.13^{a}	0.09

^{abcde}Means in the same row with different superscripts differ significantly ($P<0.05$); SEM: Standard Error of Mean.

The methionine of cassava leaves was 0.36% (Zekarias et al.., 2019) was lower to those reported in this study. All cassava varieties, except TMS 01/1371, had higher methionine in their peels than the 0.04% reported for cassava peels (Oloruntola, 2020). The methionine content of freshly peel of cassava tuber in this study ranged from 0.012 to 0.014% compared favourably with 0.014% reported by Nassar et al. (2009) for cassava cultivar UnB01.

Lysine content of tuber and products from five cassava varieties

The Lysine (g/kg) of tuber and products of five cassava varieties are presented in Table 3.2. Freshly peeled tuber of TMS 01/01371 had lysine content of 0.31g/kg, which was significantly higher (p<0.05) than 0.18g/kg in TMS 01/1412. The TMS 01/1371 with 0.33 g/kg and TMS 01/1368 with 0.33 g/kg) were similar (p>0.05) in their content of lysine. Also, TMS 07/0593 (0.32 g/kg) and TME 419 (0.32 g/kg) had similar (p<0.05) lysine levels in their garri.

Table2: Lysine content (g/kg) of tuber and products from five cassava varieties

Product	TMS 01/1412	TMS 01/1371	TMS 01/1368	TMS 07/0593	TME 419	SEM
Freshly peeled tuber	0.18^{e}	0.31^{a}	0.29^{c}	0.25^{d}	0.30^{b}	0.01
Garri	0.44^{a}	0.330^{b}	0.330^{b}	0.320^{c}	0.320^{c}	0.01
Garri flour	0.32^{d}	0.54^{a}	0.38^{b}	0.22^{e}	0.35^{c}	0.22
Grit	0.78^{b}	0.89^{a}	0.59^{e}	0.70^{c}	0.66^{d}	0.03
Grit flour	0.80^{b}	0.93^{a}	0.38^{e}	0.47^{d}	0.54^{c}	0.06
Peelings	1.820^{d}	1.12^{e}	2.00^{a}	1.900^{c}	1.970^{b}	0.09
Peels	2.11^{b}	1.52^{e}	2.02^{c}	2.27^{a}	1.90^{c}	0.07
Leaves	14.22^{b}	11.15^{d}	12.73^{c}	14.09^{b}	14.86^{a}	0.30

^{abcde}Means in the same row with different superscripts differ significantly (P<0.05); SEM: Standard Error of Mean.

Lysine is the first limiting amino acid in swine nutrition and the second limiting amino acid in some poultry and ruminant diets (Dalibard et al., 2014). Grit is obtained by air frying to obtain the final products, however, the study showed that heat treatment employed increased the lysine content of grits made from cassava varieties TMS 01/1368, TMS 07/0593 and TME 419. However, TMS 01/1412 and TMS 01/1371 varieties had grit with lower lysine content compared with grit flour. The lower values in grits from TMS 01/1412 and TMS 01/1371 agreed with those of Dalibard et al. (2014), showing heat treatment like toasting, lowers lysine contents due to Maillard reactions.

Lysine is an amino acid which is deficient in most of the cereals consumed globally (Sanchez and Demain, 2014). Lysine content of products such as cassava peels has been reported to be low (Aro and Aletor, 2012). Nassar and Sousa (2007) opined that development of cassava varieties with improved lysine content would enhance its value in food and feed. Increased dietary lysine has been linked to improved FCR and performance (Weurding et al., 2003). The lysine contents of the casava products studied (0.018-1.486%) were higher than 0.01% reported for cassava (Morgan and Choct, 2016). Cassava peel products were lower in lysine than 2.31% reported (Aro and Aletor, 2012). The reported 0.356% lysine in cassava grits (Abioye et al., 2022), was lower than recorded in this study, Lysine in cassava grits ranged from 0.59% (TMS 01/1368) to 0.89% (TMS 01/1371). The lysine content of cassava grits improved by varietal differences, indicating improvements in cassava lysine levels of their products. All the cassava products assessed showed likelihood of their suitability for replacing maize as they contained higher lysine content compared to maize which reportedly contained lysine range of between 0.15 and 0.25% (Chand et al., 2022).

CONCLUSION

The processing of cassava and its by-products such as leaves and peels offer promising prospects of reducing wastes when purposefully channeled for production of animal feed. Cassava variety TMS 01/1412 showed consistently high essential amino acids compared to other varieties across the products considered.

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