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Full Length Research Article

Study of Bioavailability of Ca and Zn in the Flesh of Yellow *Terminalia catappa (Linn)* Fruits

***[1]M.I. Barde, [2]L.G. Hassan, [2]U.Z. Faruq, [3]S.A. Maigandi and [2]K.J. Umar**
[1]Department of Chemistry, Umaru Musa Yar'adua University, P.M.B 2218, Katsina, Nigeria
[2]Department of Pure and Applied Chemistry, Usmanu Danfodiyo University, P.M.B. 2346, Sokoto, Nigeria
[3]Department of Animal Science, Faculty of Agriculture, Usmanu Danfodiyo University, P.M.B. 2346, Sokoto, Nigeria
[Corresponding Author:E-Mail: bardemagaji@gmail.com; ☏: +234(0)8034316196]

ABSTRACT: The analyses of antinutritional and mineral composition of the flesh of yellow fruits variety of *Terminal catappa* using standard methods were conducted. The results (mg/100g dry sample) are as follows: Total oxalate 1.90, soluble oxalate 1.62, tannin 16.28, phytate 2872.67, saponin 1.495, nitrate 0.64, hydrocyanic acid 4.19, Ca 143.30, Mg 48.50 and Zn 1.42. Bioavailability studies revealed that the oxalate content of the fruit have no effect on Ca availability as Oxalate]/[Ca] and [Oxalate]/[Ca + Mg] are below critical level of 2.5. However, phytate affect both the Ca and Zn bioavailability with [Phytate]/[Ca] and [Ca][Phytate]/[Zn] above critical level of 0.2 and 0.5 respectively.
Keywords: Anti-nutritional, *Terminal catappa*, fruits, minerals, bioavailability.

INTRODUCTION

Nutrients ingested but not released during the digestive process for absorption are of no nutritional value. Thus, an assessment of the adequacy of dietary intakes of nutrients requires not only knowledge of the nutrient content of the foods ingested but also the extent to which the nutrient present in the diet is available for absorption and utilization (Sauberlich, 1985). Presence of some chemical compounds - anti-nutritive factors, such as oxalates, phytate, tannin, nitrate, hydrocyanic acid and saponins in food affect nutrients particularly divalent minerals and protein (Bhandari and Kawabata, 2004; Umar, 2005).

For example, phytate is known to have lower mineral bioavailability by forming insoluble phytate-metal complex, thereby decreasing the bioavailability of these elements for absorption (Bhandari and Kawabata, 2004). Phytic acids also have a negative effect on amino acid digestibility, thereby causing problem to non-ruminant animals due to insufficient amount of intrinsic phytate necessary to hydrolyze the phytic acid complex (Turner *et al*., 2002). Oxalate was also reported to removes calcium from the blood in the form of calcium oxalate and may cause gallstone resulting to kidney damage (Muhammad *et al.*, 2011).

One of the major sources of these antinutritional compounds is consumption of plant food products in unprocessed form. Among the plants consumed in an unprocessed form is *Terminalia catappa* (Plate 1). Its fruits are widely consumed and its proximate composition has been reported by Hassan *et al.* (2011). There is lack of sufficient information on the fruits anti-nutritional status and minerals bioavailability. This is the motive of this study.

Plate 1: Yellow of *T. catappa* fruits

MATERIALS AND METHODS

Fresh *T. catappa* fruits were plucked from Runjin Sambo in Sokoto metropolis. Prior to analysis, the flesh was removed using sharp laboratory knife, sun dried, milled into fine powder, sieved through 20-mesh and stored in airtight polythene bag. Quantitatively ant-nutritive factors were determined as follows; total and soluble oxalate as oxalic acid was estimated by redox titration with standard potassium permanganate, according to the procedure of Krishna and Ranjhan (1980). Saponin was determined using the method of Obadoni and Ochuko (2001). Phytic acid as phytate was quantified in accordance with the procedure of Ola and Oboh (2000). Tannic acid was determined in accordance with the procedure of AOAC (1990), nitrate was analyzed by the methods of Krishna and Ranjhan (1980) and hydrocyanic acid by quantified AOAC (1990).

For Ca, Mg and Zn determinations, 2g of the dried sample were digested with 24cm^3 mixture of nitric acid/perchloric/sulphuric acids in the ratio 9:2:1 respectively and analyzed by atomic absorption spectrophotometry. Bioavailability of minerals element was predicted using mole ratio concept (Umar, 2005).

Statistical Analysis

All the analyses were carried out in triplicate and result expressed as mean ± standard deviation.

RESULT AND DISCUSSION

Antinutritional factors

The result of antinutritional factors is presented in Table 1. The fruit total oxalate (1.90mg/100g) and soluble oxalate (1.62mg/100g) content is similar to 1.89mg/100g reported in pawpaw (Onibun *et al*., 2007). Other well known fruits such as banana, apple, guava and sweet orange were also reported to contain comparably higher amounts of oxalate (4.50, 3.15, 2.43 and 2.48 mg/100 g respectively) as reported by Onibun *et al*. (2007).

Phytate content of *T. catappa* fruits was higher than the corresponding values of 80, 86 and 90 mg/100g reported for guava, mango and pineapple (Suree *et al.,* 2004). It can be interpreted that long term consumption of the sample could led to decrease in mineral bioavailability in monogastric animals (Thompson, 1993).

The *T.catappa* fruits tannins content is high compared with banana (3.40mg/100g), apple (8.50mg/100g) and pawpaw (10.1mg/100g), but lower than 20.36mg/100g and 48.16mg/100g for guava and sweet orange respectively (Onibun *et al*., 2007).

The *T. catappa* fruits have low saponins level which is comparable to 1.50 mg/100g reported in *Vittaleria paradoxum*, but lower than 6.01mg/100g for *Balanite aegyptiaca* (Umaru *et al*., 2007). High saponin level has been associated with gastroenteritis manifested by diarrhoea and dysentery (Awe and Sodipo, 2001).

The concentration of nitrates in the sample is 0.64mg/100g for yellow *T.catappa* fruits. This value is lower than the acceptable daily intake (ADI) of 3.7mg/kg body weight which is equivalent to 220mg for 60kg person (WHO, 2002).

The hydrocyanic acid content in the sample was 4.19 mg/100g. The data shows that the sample have low HCN content which is below the toxic level of 35mg/100g dry weight (Isong *et al*., 1999) and 20mg HCN equivalent kg^{-1} sample recommended by Standard Organization of Nigeria (SON) (Edijala *et al*., 1999).

The sample calcium, magnesium and zinc contents are 143.30, 48.50 and 1.42 mg/100g respectively. To predict their bioavailability, minerals to antinutritional factors ratios were evaluated and presented in Table 2. [oxalic acid:Ca] and [Oxalate]/[Ca + Mg] are indices of calcium unavailability. From the results it can be concluded that the oxalate level in the sample has no effect on calcium bioavailability as the values are below the critical level known to impair calcium absorption. On the other hand, [Phytate]/[Ca] ratio of 1.21 is greater than the critical value. This is an indication that phytate level is the factor that may affect calcium bioavailability by forming insoluble calcium-phytate complex. Similarly, [Ca][Phytate]/[Zn] is above the critical level, which indicates that phytate exert strong effect on zinc bioavailabilty. Thus a sample could not be regarded as a good source of zinc.

Table 1: Antinutritive Factors, Ca, Mg and Zn Content in the Flesh of Yellow Fruits of *T. catappa* (mg/100g dry weight)

Parameter	Yellow Fruits
Total oxalate	1.90 ± 0.14
Soluble oxalate	1.62 ± 0.21
Phytate	2,872.67 ± 42.50
Tannins	16.28 ± 0.48
Saponin	1.49 ± 0.01
HCN	4.2 ± 0.29
Nitrate	0.06 ± 0.01
Ca	143.30 ± 6.63
Mg	48.50 ± 0.88
Zn	1.42 ± 0.12

*The data are mean value ± standard deviation (n =3).

Table 2: Antinutritive to Nutrient Molar Ratio of *T. catappa* Yellow Fruits Flesh

Molar Ratio	**Value**	**Critical level***
[Oxalate] / [Ca]	0.005	2.5
[Oxalate] / [Ca + Mg]	0.003	2.5
[Phytate]/[Ca]	1.21	0.2
[Ca][Phytate]/[Zn]	713.76	0.5

*** Source:** Umar (2005).

CONCLUSION

Yellow varieties of *Terminalia catappa* fruits were analysed for oxalate, phytate, nitrate, hdrocyanic acid and minerals contents. Ca and Zn bioavailability was also investigated. The fruits contain high amounts of phytate and oxalate which reduce bioavailability of Ca and Zn. HCN and nitrate concentrations are low. The bioavailability studies reveal calcium availability and zinc unavailability.

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