

**NSAP****47th Annual Conference**
(JOS 2022)**CONFERENCE PROCEEDINGS**THEME
SECURING ANIMAL
AGRICULTURE AMIDST
GLOBAL CHALLENGES**CALCIUM, ZINC AND PHYTATE INTERRELATIONSHIPS IN FONIO (*Digitaria exilis* AND *Digitaria iburua*) OFFALS***Sudik, S. D¹.; Agbede, J. O².; Igbasan, F. A².; Maidala, A¹.; Bizi, S. B¹.; Ali, G¹. and Mohammed, B. G¹.¹Department of Animal Science, Federal University, Gashua, Yobe State, Nigeria²Department of Animal Production and Health, Federal University of Technology, Akure, Ondo State, Nigeria*Corresponding author's email: davidsudik@yahoo.com Mobile Phone: 08065633451**ABSTRACT**

Fonio (Digitaria exilis and Digitaria iburua) offals are sought as alternative fibre sources in monogastric feed formulations because they are less expensive, readily and locally available in areas where they are produced. Calcium and zinc in plant sources are usually not available for monogastric animals due to the presence of phytate and monogastrics lack phytase enzyme that will digest it. Therefore, this paper aimed at determining the calcium, zinc and phytate interrelationships of fonio (D. exilis and D. iburua) offals. The molar ratios [Phy]: [Zn], [Ca]: [Phy] and [Ca][Phy]: [Zn] were used. The calculation showed that [Phy]: [Zn] molar ratios of both offals were greater than 10 and less than 15 (critical level is value lower than 10 and greater than 15). Also, the [Ca]: [Phy] molar ratios of both offals were above 6.1 (critical level is value lower than 6.1); and the [Ca][Phy]: [Zn] molar ratios of both offals were also lower than 200 (critical level is value greater than 200). In conclusion it can be predicted that phytate content in fonio offals may not be high to prevent the absorption of calcium and zinc. Therefore, fonio offals are recommended for monogastric species.

Keywords: Calcium, fonio, monogastrics, offals, zinc.**INTRODUCTION**

Fonio is the term for two cultivated grasses in the genus *Digitaria* that are notable crops in parts of West Africa (Cruz,2004). 1) *Digitaria exilis* also called "hungry rice" by Europeans, and "acha" in Nigeria. A white grain grows from Senegal to Chad, as well as in central Nigeria (Gyang and Wuyep, 2005). It's the most commonly eaten of the two varieties and more readily available outside Africa (Cruz,2004). The republic of Guinea produced over 75% of the world's production in 2019 (Wikipedia, 2021). 2) *Digitaria iburua* also called "iburu" in Nigeria. A white grain has black or brown spikelets and grows mainly in parts of Nigeria, Togo, and Benin (Gyang and Wuyep, 2005). Ballogou *et al.* (2013) reported that Fonio provides numerous B vitamins, as well as minerals like calcium, iron, copper, zinc, and magnesium and emphasized that fonio has the highest calcium content of all cereal grains. Fonio has the smallest seeds of all cereal grains and removing the hull from seeds is time-consuming (Ballogou *et al.*, 2013). The hulls (by-product) are thrown as waste while the inner (endosperms) are used in various fonio foods such 'wusu-wusu'; tuo (tuwo), "gwete", "acha jollof", and "kunu acha" (Jideani, 2012). The whole grain has three parts: the hull, endosperm, and germ. The hull and germ may not be separated during processing hence; the mix formed the fonio offal. About 25% of a grain's protein is lost when the offal is removed (Ballogou *et al.*, 2013). Several experiments were conducted with the offal as source of fibre and reported positive results: Sudik (2016) tested 15% *D. exilis* offal on performance of broiler chickens; Sudik *et al.* (2019) tested 15% *D. iburau* offal on haematology and serum biochemistry of broiler chickens; Sudik and Ajiji (2021) tested 100% *D. exilis* offal on performance of male growing rabbits and Sudik *et al.* (2021) tested 100% *D. exilis* offal on amino acid digestibility of male growing rabbits. It should be noted that heat treatment or any other treatment is applied on the grain when removing the offals, it therefore means that the offal goes with component of anti-nutritional factors since most plant food materials are known to contain anti-nutritional factors. Sudik and Gofwan (2017) reported that both types of fonio contain phytic acid, also known as inositol-6-phosphate or phytate in its salt form. It is the principal storage form of phosphorus in many plant tissues (Hambidge *et al.*, 2011). According to Hambidge *et al.* (2011) the phytate is not digested by

monogastric animals and humans, because they lack the digestive enzyme phytase, required to remove minerals from the inositol in the phytate molecule while animals need these minerals for normal growth, development, and immune function (Troesch *et al.*, 2013). The phytic acid chelates mineral ions such as iron (Fe^{3+}), zinc (Zn^{2+}) and calcium (Ca^{2+}) (Schlemmer *et al.*, 2009). However, Schlemmer *et al.* (2009) observed that the function of the chelate depends on relative levels of minerals and phytic acid. Therefore, several authors (Adeyeye *et al.*, 2000; Lonnerdal, 2000) have proposed [phy]:[Zn] molar ratio as an indicator of zinc bioavailability and [Ca]: [Phy] molar ratio as indicator for calcium availability. The kinetic synergism existing between calcium and zinc made Adeyeye *et al.* (2000) to suggest [Ca]: [Phy]/ [Zn] molar ratio as a better predictor of zinc bioavailability. Foodstuffs with [phy]: [Zn] and [Ca]: [Phy]/ [Zn] greater than 10 and 200 respectively are at risk of zinc deficiencies; and foodstuffs with [Ca]: [Phy] molar ratios lower than 6.1 are at risk of calcium deficiencies (Allen *et al.*, 2006; Lonnerdal, 2000; Lopez *et al.*, 2002). Therefore, this paper aimed at determining the calcium, zinc and phytate interrelationships of fonio (*Digitaria exilis* and *Digitaria iburua*) offals.

MATERIALS AND METHODS

The calcium, zinc and phytate contents of fonio (*D. exilis* and *D. iburua*) offals reported by Sudik (2016) were used in this paper. The [Phy]: [Zn], [Ca]: [Phy] and [Ca][Phy]: [Zn] molar ratios were calculated using the formulas adopted by (Oloruntola, 2015).

$$[\text{Phy}]: [\text{Zn}] = \frac{\text{Phy (mg/100g)}/\text{MW}}{\text{Zn (mg/100g)}/\text{MW}}$$

$$[\text{Ca}]: [\text{Phy}] = \frac{\text{Ca (mg/100g)}/\text{MW}}{\text{Phy (mg/100g)}/\text{MW}}$$

$$[\text{Ca}][\text{Phy}]: [\text{Zn}] = \frac{[\text{Ca (mg/100g)}/\text{MW}] \times [\text{Phy (mg/100g)}/\text{MW}]}{\text{Zn (mg/100g)}/\text{MW}}$$

RESULTS AND DISCUSSION

The calculated [Phy]: [Zn], [Ca]: [Phy] and [Ca][Phy]: [Zn] molar ratios of the fonio offals are shown in Table 1. The [Phy]: [Zn] molar ratios were similar in both offals. According to Adeyeye *et al.* (2000), Allen *et al.* (2006), Lonnerdal (2000) and Lopez *et al.* (2002) that foodstuffs with [Phy]: [Zn] molar ratios less than 10 have no risk of Zn availability and a deficiency problem will be encountered when values are greater than 15. Thus, it can be predicted that consumption of these offals will not precipitate zinc deficiency. In regards to [Ca]: [Phy], the molar ratios were also similar in both offals and as stated above foodstuffs with [Ca]: [Phy] higher or equal to 6.1 show calcium availability but when values are lower than 6.1 is an indicator of calcium deficiency (Adeyeye *et al.*, 2000; Allen *et al.*, 2006; Lonnerdal, 2000; Lopez *et al.*, 2002). This corroborated with the report of Sudik (2016) that minerals content of grains is more concentrated in the hull. As a comparison, the molar ratio of maize grain was reported as 5.4 (Adeyeye *et al.*, 2000) and 5.4 is lower than 6.1 which depicts that consumption of maize alone precipitates deficiency of calcium. In regards to [Ca][Phy]: [Zn] molar ratios both offals also had similar values and are lower than 200 the critical value. This further predicts bioavailability of zinc. By implication, the inositol in the phytate molecule is not high to prevent absorption of calcium and zinc.

Table 1: Calculated [Phytate]: [Zn], [Ca]: [Phytate] and [Ca][Phytate]: [Zn] molar ratios of fonio offals

Parametrs	<i>Digitaria exilis</i>	<i>Digitaria iburua</i>
[Phy]: [Zn]	11.62	11.62
[Ca]: [Ph]	6.44	6.47
[Ca][Phy]: [Zn]	17.80	17.50

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CONCLUSION

It was observed in this paper that the phytate content in fonio offals is not high to mimic calcium and zinc absorption. Therefore, fonio offals are recommended for monogastric livestock species.

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