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Proximate composition of red and black finger millet (*Eleusine coracana*) varieties

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Abstract

The aim of determining the proximate composition of red and black finger millet/Tamba (Eleusine coracana) varieties was to ascertain their nutritional composition and their ability to be used as feed ingredients. The finger millets used in this experiment were purchased from local markets in Ganawuri of Plateau and Manchok in Kaduna States and were subjected to proximate analysis. The results revealed that the millets contained Dry Matter – 88.48 and 87.55 %; Crude Protein (CP) – 13.98 and 13.14 %; Ether Extract (EE) – 3.70 and 3.10 %; Crude Fiber (CF) – 6.67 and 7.02 %; Ash – 4.90 and 4.36 %; Nitrogen Free Extract (NFE) – 59.22 and 59.84 % for the red and black finger millets, respectively. Based on these results, it can be concluded that finger millet is a nutritious feed resource irrespective of the variety and can be incorporated into animal feed in the livestock industry. It is recommended for farmers to use the crop by incorporating into livestock feed because of its rich proximate composition.

Keywords: Finger millet, Proximate, Feed resource, Livestock, Nutrients

La Composition immédiate des variétés de mil rouge et noir *(Eleusine coracana)*

Résumé

L'objectif de la détermination de la composition immédiate des variétés de mil rouge et noir / Tamba (Eleusinecoracana) était de vérifier leur composition nutritionnelle et leur capacité à être utilisées comme ingrédients alimentaires. Des variétés de mil rouge et noir utilisées dans cette expérience ont été achetées aux marchés locaux de Ganawuri de l'état de Plateau et de Manchok del'état de Kaduna et ont été soumises à une analyse immédiate. Les résultats ont révélé que les variétés de mil contenaient de la matière sèche - 88,48 et 87,55% ; Protéine Brute (PB) –13,98 et 13,14% ; Extrait d'éther (EE) –3,70 et 3,10% ; le 'crude fibre' (CF) –6,67 et 7,02% ; Cendres – 4,90 et 4,36% ; Extrait sans azote (le 'NFE') –59,22 et 59,84% pour les mil rouges et noirs, respectivement. Sur la base de ces résultats, on peut conclure que le mil rouge et noir est une ressource alimentaire nutritive quelle que soit la variété et peut être incorporée dans l'alimentation animale dans l'industrie de l'élevage. Il est recommandé aux agriculteurs d'utiliser la culture en l'incorporant dans l'alimentation du bétail en raison de sa riche composition immédiate.

Mots clés :mil, composition immédiate, ressource fourragère, bétail, nutriments

Introduction

The term millet is derived from the French word "mille" which means thousand, with a handful of millet containing up to 1000 grains (Shahidi and Chandrasekara, 2013). *Eleusine coracana* is called *kpana* by the Beroms, *tamba* in Hausa (Fernandez *et al.,* 2003). It is called *ragi* by the Indians; in Ethiopia, *its dagussa* in Amharic, *tokuso* in Soddo, *barankiya* in Oromo and *bulo* in Uganda (Gull *et al.,* 2015). Millet belongs to the group of small seeded species of cereal crops or grains which are annual plants (Shiihii *et al*., 2011). The grain belongs to the family Poaceae which originated in Ethiopia and the sub-family *Chloridodeae* (Pradeep and Sreerama, 2015; Sood *et al*., 2016). The grain is a semi-arid region crop cultivated in dry areas with limited rainfall and can adapt to various agro-climatic conditions (Gull *et al*., 2014). D'Andrea *et al.* (1999) reported finger millet to be a native of East Africa-Ethiopia and Ugandan highlands. The crop is generally considered as high drought tolerant and for the very long storage time which may be up to 50 years. The long storage capacity makes finger millet an important crop in risk-avoidance strategies as a famine crop for poor farming communities (NRC, 1996). Finger millet is especially valuable as it contains the amino acid, methionine, which is lacking in the diets of hundreds of millions of the poor who live on starchy staples such as cassava, plantain, polish rice or maize meal, it is also rich in Iron and the straw can be used as animal feed. Hence, it is important to look at ways of how to economically and effectively substitute some of the conventional feed resources that are available with alternative feed resources, since they are becoming scarce and beyond the reach of the small and medium entrepreneur farmers. Globally, finger millet exists in different varieties and colour which are found from one region to the other. Sood *et al.* (2017) stated that brown cultivar is utilized for brewing traditional opaque beer in Southern Africa. In Nigeria, it is popularly and widely grown in some parts of Plateau and Kaduna states, it contains appreciable quantities of essential nutrients including amino acids and minerals that make it a useful food supplement for the people of northern Nigeria (Fernandez *et al*., 2003). Another aspect of the finger millet is that the straw from it can be used in feeding ruminants. These attributes make this crop a very good source of feed for the livestock especially poultry birds that have capacity to reciprocate the good nutritional value of the cereal. Hence, the need to determine the nutritional contents of red and black finger millet so that farmers can be encouraged to adopt its usage in feed formulation and compounding their feed.

Materials and methods

Source of finger millet

The grain which is popularly called finger millet or *tamba* locally was purchased from Ganawuri local market which is located in Riyom Local Government Area of Plateau State and Manchok in Kaura Local Government Area of Kaduna State.

Proximate analysis of finger millet (Eleusine. coracana)

Stones, pebbles and stalks were hand-picked, and chaff were blown off from the finger millet before being taken to the laboratory for analysis.

Determination of finger millet proximate composition

Samples of red and black varieties of finger millet were taken for proximate composition at the Biochemistry Laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria, Kaduna State, Nigeria. The analysis was carried out according to AOAC, (2006).

Determination of nitrogen and crude

protein

In the micro Kjeldhal method, about 0.5 g part of the sample was weighed and transferred into a Kjedahl flask. Using a measuring cylinder, about 5 mL concentrated sulphuric acid and one tablet of Kjeldhal catalyst were added to the flask. The flask in an inclined position was gently heated in a fume cupboard, using a heating mantle. When the initial vigorous reaction had died down, the heat was increased and digestion was continued until the liquid was clear and free from black or brown colour. The flask was allowed to cool and the mixture transferred to a 100 mL volumetric flask, diluted with distilled water to the mark. About 10 mL of the sample aliquot and 15 mL of 40 % Sodium Hydroxide solution was transferred into the distillation apparatus consisting of the flask (500 mL capacity), stopper carrying a dropping funnel and a splash head adaptor: a vertical condenser. Ten milliliters (10 mL) of 2% Boric Acid solution was measured into a 250 mL conical flask, and a few drops of screened methyl red indicator were added to the flask and then placed on the receiver so that the end of the delivery tube is below the level of the boric acid. A few pieces of granulated zinc and some anti-dumping granules were added to the distillation flask. The apparatus was shaken gently to ensure mixing of the contents. The flask was boiled vigorously until about 25 mLl distillate was obtained. The receiver was removed and titrated against a standard acid 0.025 M H_2SO_4 till a pink colour end point (TV) was reached.

$N (\%) = (0.014 \times TV \times 100 \times 0.025)/ (W \times 10) \times 100$

Where W is weight of sample taken.

$\% \text{protein} = N \times F$

Where F is a factor equal to 5.70 for flour, 6.38 for milk, 5.55 for gelatine and 6.25 for all other foods.

Determination of fat content

Filter paper free from fat was weight (W1). About 1 g of the sample was added into the filter paper, carefully folded and tied to keep the sample intact, the new weight noted (W2). A 500 ml round bottom flask was filled up to three-quarter with solvent (n-Hexane). The flask was fitted to Soxhlet extraction apparatus with a reflux condenser and placed on an electro-mantle heater. Extraction began as the solvent started refluxing several times. Extraction continued for about 6 hours after which the condenser was detached, the defatted sample removed, and dried to a constant weight in the oven at 105°C for 2 hrs. The difference between the weights of the defatted sample before and after drying was recorded as the weight of fat (W3).

$\text{Fat} (\%) = (W2 - W1)/W3 \times 100$

Determination of crude fibre

About 5 g of the sample were weighed (W1) and defatted by ether extraction with Soxhlet apparatus and dried. The sample was transferred quantitatively by brushing in a 600 mL beaker of the fibre digestion apparatus while 200 mL of 1.25 % sulphuric acid was added. The beaker was placed on digestion apparatus with pre adjusted heater and boiled for exactly 30 minutes. The beaker was removed and the contents were filtered through California Buchner funnel. The beaker was rinsed with 75 mL of boiling water and washed through the funnel. The washing was repeated 3 times with 50 mL portion of water and then sucked dry. The residue was returned to the beaker by blowing back through the funnel; and 200 mL of boiling deionized water and 1.25 % Sodium Hydroxide was added to the beaker and boiled for 30 minutes and the beaker was removed and filtered. The residue was then washed with 25 ml of boiling 1.25 Sulphuric acid, followed by three 50 mL portion of water and 25 ml of alcohol, respectively. The fibre mat and the residue were then dried at $130 \pm 2\ ^{o}C$ for 2

hours. It's then cooled in a desiccator and weighed (W2).
It was ignited at 600 °C ± 15 for 30 minutes. The dishes were removed and cooled in a desiccator and weighed (W3).
The Crude Fibre was calculated as follows:
(%) Crude fibre = (W2– W3) / (W1) × 100
Where:
W1 = weight of sample
W2 = weight of crucible + sample after drying
W3=weight of crucible + sample after ashing

Determination of ash content

Crucible was pre-heated in the oven for 30 mins at 105°C, cooled in the desiccator for about 1hr and weighed (W1). One gram of the sample was added into crucible, given a new weight (W2)
It was then placed in the muffle furnace to ash at 55°C for 3 hours until the content became whitish in colour with no black particles, it was removed and cooled in the desiccator, the weight was noted (W3).
% Ash = (W2 – W3)/ (W2 – W1) Where
W1 = weight of crucible
W2 = weight of crucible + sample before ashing
W3 = weight of crucible + sample after ashing

Results and discussion

The proximate composition results for red and black finger millets are presented in Table 1. The result showed that red finger millet had a crude protein (CP) content of 13.98 % and black finger millet had CP of 13.14 %. These values are higher than that of the other members of the millet family, such as foxtail millet (10.29 %), burnyard millet (6.93 %) reported by (Verma *et al*., 2014). Other authors reported various concentrations of CP as follows; Rao (1994) 8.7 %; Chethan and Malleshi (2007) 5-8 %; Gupta *et al.,* (2011) 7.5 – 9.56; David *et al.* (2014) 10.28 %; Ravishankar *et al.* (2003) 9.1%; Banusha and Vasantharuba, (2013) 10.66±0.18 %; Sanusi *et al*. (2019) 10.09±0.02 % and Fasasi (2009) 5.68±0.51 %. The results obtained in this work are comparable to the observation of Vadivoo *et al.* (1998) who reported a CP range of 6.68 – 12.34 % for varying seed colours of finger millet, with brown or red colour having the highest CP content and Rotimi (2011) reported the value of 14.0±0.01 % for finger millet. These differences in the composition could be due to geographical locations and soil type. The high CP of finger millet makes it a very nutritionally important ingredient for animal feed, since protein is very vital for normal functioning of the entire body system. Pugalenthi *et al.* (2004) reported that proteins are essential components of the diet needed for survival of animals and humans; their basic function in nutrition is to supply adequate amount of required amino acids.
The ether extract or crude fat obtained from the analysis of finger millet revealed that red and black colours had 3.70 % and 3.10 %, respectively. This is higher than 1.214.0±0.01 % reported by Ravishankar *et al.* (2003); 0.83 % by David *et al.* (2014); 1-2 % by Chethan and Malleshi (2007). Other authors including (Lupien, 1990; Bhatt *et al*., 2003; Fasasi, 2009; Banusha and Vasantharuba, 2013) in their studies reported 1.3-1.8 %; 1-1.7 %; 1.68±0.62 % and 1.42±0.11 %, respectively. However, it is comparable to 3.24±0.22 %, 2.4± 0.02 % and 2.1 % reported by Sanusi *et al*. (2019); Abubakar *et al*. (2015) and Anthony *et al*. (1996). High fat ingredients are suggested for inclusion in weight gaining diets because of the energy embedded in them. Leeson (1997) reported that fats are widely used energy sources in addition to improving the consistency and palatability of mash feed.
The proximate composition revealed ash content of 4.90 % for red and 4.36 % for

black finger millet. This is higher than 2.37 % stated by David *et al.* (2014), 1.7 % by Rao (1994); 2.2 ± 0.02 % by Abubakar *et al.* (2015) and 1.94±0.17 % by (Sanusi *et al.,* 2019). Rotimi (2011) reported 4.22±0.01 %; Banusha and Vasantharuba (2013) reported 2.84±0.13 %; while Fasasi (2009) reported 2.21±0.05 % for finger millet. Singh and Srivastava (2006) recorded a range of 1.4 – 2.58 % for 16 varieties of finger millet, 3.10 % for foxtail millet, but comparable to the findings of Verma *et al.* (2014) as 4.27 % for burnyard millet. The differences recorded may be due to the different types of fertilizer used and the methods of application and their varietal seed coat colours found in those areas. This suggests that red finger millet has more content of inorganic or minerals in it than the black finger millet. This also suggests that the ash content of a substance or ingredient gives an idea about the inorganic matter or mineral contents of such a substance. This result agreed with the report of Singh and Raghuvanshi (2012) that the ash content in finger millet is higher than what was obtained in the commonly used cereal grains.

The result of crude fibre (CF) showed that red finger millet had 6.67 % while black finger millet had 7.02 %. These values were higher than 3.7 % reported by Ravishankar *et al*. (2003); 3.10 % by David *et al.* (2014); 3.21±0.02 % by Sanusi *et al*., 2019); 3.94±0.36 % by (Banusha and Vasantharuba, 2013); 4.34±0.10 % by Rotimi (2011) and 3.51±0.01 and 1.2 ± 0.05 % reported by Fasasi (2009) and Abubakar *et al*. (2015) respectively. Similarly, CF values reported in this study were higher than those reported by Verma *et al.* (2014) for Foxtail millet (4.25 %) and burnyard millet (2.98 %).). Crude fibre is nutritionally important as it aids the absorption of trace elements in the gut and elimination of undigested waste through the bowel (Abolaji *et al*., 2007). Viscosity promoting potential of CF has also been shown to reduce the overall digestive absorptive efficiency by preventing nutrients from being available at the absorptive sites in the intestinal mucosa (Webel *et al*., 2003).

The nitrogen free extract (NFE) obtained from this work were 59.22 % and 59.84 % for red finger millet and black finger millet respectively. These results were lower than what was recorded by Ravishankar *et al.* (2003) as 77.9 %; David *et al.* (2014) 76.43 %; Chethan and Malleshi (2007) 65.75 % and Abubakar *et al*. (2015) 79.53 ± 0.06 %. According to the findings of Gull *et al*. (2015) finger millet had 72 % while wheat is 71.9 %; Verma *et al.* (2014) reported 69.95 % for foxtail, 71.87 % for burnyard millet and 80.58 % for rice.

Table 1: Proximate composition of red and black Finger millet (*Eleusine coracana)* (%)

	% Nutrient composition	
Parameter	**Red variety**	**Black variety**
Dry matter	88.48	87.55
Crude protein	13.98	13.14
Ether extract	3.70	3.10
Crude fiber	6.67	7.02
Ash	4.90	4.36
Nitrogen Free Extract	59.22	59.84

Conclusion

Therefore, it can be concluded that the nutrient composition of red and black finger millets are nutritious and comparable, suggesting that they could be used as an alternative source of animal feed.

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