Proximate and Phytochemical Compositions of Black Seed (*Nigella Sativa*), African Nutmeg (*Monodora Myristica*) and Negro Pepper (*Xylopia Aethiopica*)

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Abstract

Phyto-additives are consumed for their medicinal properties or as spices due to their taste and flavour. Black seeds (*Nigella sativa*), African nutmeg (*Monodora myristica*) and Negro pepper (*Xylopia aethiopica*) were analyzed for their proximate, minerals and phytochemical compositions to assess their possibilities of being utilized in livestock production. Black seed and Negro pepper had higher crude protein (21.03 vs 17.43%, respectively), crude fibre (6.90 vs 5.88%), ether extract (37.91 vs 11.67%) and ash (7.42 vs 7.24%) than African nutmeg (13.54, 2.20, 6.77 and 4.59%) respectively. However, Negro pepper contained the highest metabolizable energy content (3500Kcal/kg), closely followed by African nutmeg (3145.05Kcal/kg) while black seed showed the lowest metabolizable energy content (2890.05Kcal/kg). Black seed contained the highest calcium, magnesium, phosphorus and Iron contents. Negro pepper showed the highest contents for manganese, zinc, selenium and copper. African nutmeg displayed intermediate values for the macro and micro minerals content measured in this study. Negro pepper has the highest values (0.48, 0.04, 0.32 and 0.07%) for alkaloids, flavonoids, saponin and oxalates, respectively while Black seed has the highest tannin content (0.05%). The findings indicate that these phyto-additives might be good sources of valuable nutrients for human and animal use.

Keywords: Phyto-additives, Black seed, African nutmeg, Negro pepper, Chemical composition

Compositions Proximales Et Phytopharmaceutiques Des Graines Noires (*Nigella Sativa*), Muscade Africaine (*Monodora Myristica*) Et Poivre Noir (*Xylopia Aethiopica*)

Résumé

Les phyto-additifs sont consommés pour leurs propriétés médicinales ou comme épices en raison de leur goût et de leur saveur. Les graines noires (Nigella sativa), la muscade africaine (Monodora myristica) et le poivre noir (Xylopia aethiopica) ont été analysés pour leurs compositions proximales, minérales et phytopharmaceutiques afin d'évaluer leurs possibilités d'utilisation dans la production animale. Les graines noires et le poivre noir ont présenté des taux plus élevés de protéines brutes (21,03 % contre 17,43 %, respectivement), de fibres brutes (6,90 % contre 5,88 %), d'extrait éthéré (37,91 % contre 11,67 %) et de cendres (7,42 % contre 7,24 %) par rapport à la muscade africaine (13,54 %, 2,20 %, 6,77 % et 4,59 %, respectivement). Cependant, le poivre noir contenait la plus haute teneur en énergie métabolisable (3500 Kcal/kg), suivi de près par la muscade africaine (3145,05 Kcal/kg), tandis que les graines noires affichaient la plus basse teneur en énergie métabolisable (2890,05 Kcal/kg). Les graines noires contenaient les concentrations les plus élevées en calcium, magnésium, phosphore et fer. Le poivre noir présentait les plus hauts contenus en manganèse, zinc, sélénium et cuivre. La muscade africaine affichait des valeurs intermédiaires pour les macro- et micro-minéraux mesurés dans cette étude. Le poivre noir a les valeurs les plus élevées (0,48 %, 0,04 %, 0,32 % et 0,07 %) pour les alcaloïdes, flavonoïdes, saponines et oxalates, respectivement, tandis que les graines noires ont le contenu en tanins le plus élevé (0,05 %). Les résultats indiquent que ces phyto-additifs pourraient être de bonnes sources de nutriments précieux pour une utilisation humaine et animale.

Mots-clés : Phyto-additifs, Graines noires, Muscade africaine, Poivre noir, Composition chimique

Introduction

Medicinal plants can be referred to as Herbs and Spices which can be used as natural feed phyto-additives or phytobiotics. Phyto-additives have been defined by Windisch *et al.*, (2008) as plant-based compounds that are incorporated into the diets of farm animals to improve their productivity, performance and quality of products. Olomu (2011) defined feed additives as materials that are added to feed to protect animal from diseases, improving growth rate, feed efficiency and increasing overall performance. Several studies have indicated that herbs, spices and their extracts are important in sustainable animal production because they are cost effective; they are easily available; they do not have known residual effects; and no record of developing antibiotic resistance in human beings who consume the product (Ryan, 2018). Medicinal plants offer several health benefits including immune stimulation, anti-bacterial, coccidiostatic, antiviral or anti-inflammatory activity and anti-oxidant properties (Dhama *et al.*, 2015; Breijyeh and Karaman, 2024). Some of the herbs with medicinal benefits are garlic, ginger, black seeds, African nutmeg and Negro pepper.

Black seed (*Nigella sativa*) has been used medicinally dating back to the ancient Egyptian, Greek and Romans (Khan, 2016). *Nigella sativa* exhibited various medicinal properties including antifungal, antibacterial, and antioxidant potentials (Mona *et al*., 2016). Black seed and the major active substances in its oil (thymoquinone) have anti-inflammatory, antipyretic, pain-relieving Entok *et al.*, 2014), antibacterial (Morisi, 2000; Boka *et al.*, 2014), anticoccidial (Kadhim *et al.*, 2018), immune responsiveness (Al-Mufarrej, 2013; Ali *et al*., 2014), and anticancer (Randhawa and Alghamdi, 2011; Majdalawieh and Fayyad, 2016) effects in current medicine. African nutmeg (*Monodora myristica*) has a sweet-smelling scent which makes it suitable as a spicing agent (Dike, 2010). The seed contains some important bioactive compounds (Yakaiah *et al*., 2019). Nutritionally, nutmeg is rich in energy, carbohydrates, proteins, dietary fibre, vitamins (Vitamins A, C, and E) and minerals (Agbogidi and Azagbaekwe 2013). Several authors have reported that the phytochemicals in *Monodora myristica* plant can produce antioxidant, antimicrobial, antipain, anti-obesity, and hepatoprotective actions in biological systems (Agbogidi and Azagbaekwe 2013; Yakaiah *et al*., 2019). According to Nguefack, *et al.* (2004), the essential oil from the leaves contains β-caryophyllene, α-humulene and α-pinene, while the oil from the seeds contains α-phellandrene, α-pinene, myrcene, limonene and pinene. African nutmeg is rich in energy, protein, dietary fiber, and vitamins A, C and E (Ehirim *et al.*, 2017), while potassium, phosphorus, calcium and magnesium were the major minerals according to Ekeanyanwu, *et al.*, (2010).

Negro pepper (*Xylopia aethiopica*) is used as a spicy and has medicinal properties according to Isikwenu and Udomah (2015). It contains some phytochemicals such as phenols, flavonoids and carotenoids (Omodamiro *et al.*, 2012) which make it beneficial to health. Recently, the experience gathered on its use as an antioxidant and antimicrobial in human nutrition is being applied in monogastric animal nutrition due to similarity in the digestive system. Its positive result on humans could qualify it as an alternative growth promoter instead of synthetic antibiotics in animal diets (Omodamiro *et al.*, 2012; Isikwenu and Udomah 2015).

Although, additives obtained from plants are biologically active but may or may not be nutritive (Shittu *et al*., 2022). Therefore, this study was carried out to assess the nutritional and antinutritional composition of black seed, African nutmeg and Negro pepper.

Materials and Methods

1kg each of black seed, African nutmeg and Negro pepper was purchased from reputable markets within Ogbomoso metropolis, Oyo State, Nigeria.

Processing of Test ingredients for analysis

The shells of African nutmeg were removed and the seeds, black seed and negro pepper were grinded separately with Eurolex Mixer / Grinder model MG1153 (a domestic blender) into a powdery form of 0.05mm and stored in an air-tight container until needed for chemical analysis. Sub-samples of the test ingredients were analyzed for chemical composition.

Proximate analysis of the Test ingredients

Black seeds, African nutmeg and Negro pepper powder were analyzed for proximate components; Moisture content, Crude Fibre (CF), Crude Protein (CP), Ash and Ether Extract (EE) using methods of the Association of Official Analytical Chemists (AOAC, 2012). The Analyses were carried out in triplicates and values were reported in percentages. The metabolizable energy was calculated using the formular of Pauzenga, 1985: (37 x CP) + (81 x EE) + (35.5 x NFE). Where: CP - Crude protein, EE – Ether extract, NFE - Nitrogen Free Extract.

Determination of the mineral composition of Black seeds (Nigella sativa), African Nutmeg (Monodora myristica) and Negro pepper (Xylopia aethiopica)

Macro elements (sodium, potassium, calcium, magnesium and phosphorus) were determined by flame photometer while the microelements (iron, manganese, zinc, selenium and copper) were determined in triplicates using atomic absorption spectrophotometer as described in the methods of AOAC, (2012) after appropriate digestion by acids.

Determination of phytochemical composition of Black seed (Nigella sativa), African Nutmeg (Monodora myristica) and Negro pepper (Xylopia aethiopica)

Quantitative phytochemical analysis (tannin, saponins, oxalate, alkaloids and flavonoids) of Black seed (*Nigella sativa*), African Nutmeg (*Monodora myristica*) and Negro pepper (*Xylopia aethiopica*) were determined in triplicates using the methods of Harborne, (1999).

Results and discussion

The proximate composition of black seeds, African nutmeg and negro pepper is presented in Table 1. Black seed has the highest values recorded for dry matter, crude protein, crude fibre, ether extract and ash followed by Negro pepper and African nutmeg. African nutmeg had the highest nitrogen-free extract (64.69%) while the lowest was observed in black seed (25.70%). However, Negro pepper contained the highest metabolizable energy content (3500Kcal/kg), closely followed by African nutmeg (3145.05Kcal/kg) while black seed showed the lowest metabolizable energy content (2890.05Kcal/kg).

Table 2 shows the mineral composition of the black seed, African nutmeg and Negro pepper. The results for macro elements composition revealed that Negro pepper has the highest values recorded for sodium and potassium (0.11 and 0.43%) followed by African nutmeg and black seed. Black seed contained the highest calcium, magnesium, phosphorus and iron contents. Negro pepper showed the highest contents for manganese, zinc, selenium and copper. African nutmeg displayed intermediate values for the macro and micro minerals content.

The phytochemical composition of black seed, African nutmeg and Negro pepper is presented in Table 3. It was observed that Negro pepper has the highest values (0.48, 0.04, 0.32 and 0.07%) for alkaloids, flavonoids, saponin and oxalates respectively. Black seed has the highest tannin (0.05%). African nutmeg (0.02%) and

Negro pepper (0.03%) had lower tannin content than black seed.

Among the three ingredients evaluated, black seed has the highest crude protein. The outcome of the proximate composition of black seeds, African nutmeg and Negro pepper showed that they could serve as a source of protein, energy, as well as antioxidant micronutrient supplements for animals. The crude protein contents ranging between 17.43 – 21.03% were consistent with the percentage reported by other authors (Dike, 2010; Bouba *et al.,* 2012; Osabor *et al*., 2015; Borquaye *et al.,* 2017 and Kanu and Onuegbu, 2020) but higher than the value (9.22%) reported by Oso and Oladiji (2019). The crude fibre and the lipid contents were relatively higher compared to those reported for other phyto-additives such as ginger and garlic (Okolo *et al*., 2012) but were within the range reported by Mamun and Absar, (2018). In terms of minerals, the most predominant are calcium, phosphorus, magnesium, potassium and iron; this is in agreement with the works of (Aremu and Ibrahim, 2014) who reported that phosphorus, calcium and magnesium were the most abundant minerals in Nigerian plant foods. Copper, Zinc and Manganese were in trace amounts. The high level of iron in the ingredients (black seed, African nutmeg and negro pepper) is an indication that they possess hematinic properties and justifies their inclusion in some local blood tonic preparations to manage iron deficiencies (Akoto *et al*., 2015). A deficiency of iron causes anemia, a condition in which the level of iron in the body is low. This results to a decrease in red blood cell levels (Longo and Camaschella, 2015).

Table 1: Proximate composition of Black seeds, African nutmeg and Negro pepper

Parameters	Black seed	African nutmeg	Negro pepper
Dry matter (%)	95.37 ± 0.01	91.88 ± 0.02	93.70 ± 0.02
Crude protein (%)	21.03 ± 0.01	13.54 ± 0.00	17.43 ± 0.03
Crude fibre (%)	6.90 ± 0.01	2.20 ± 0.00	5.88 ± 0.01
Ether extract (%)	37.91 ± 0.03	6.77 ± 0.00	11.67 ± 0.01
Ash (%)	7.42 ± 0.00	4.59 ± 0.01	7.24 ± 0.00
Nitrogen free extract (%)	25.70 ± 0.03	64.69 ± 0.00	51.49 ± 0.00
Metabolizable energy (Kcal/kg)	2890.05 ± 0.02	3145.05 ± 0.01	3500.00 ± 0.01

The phytochemical contents of the three samples were relatively low when compared to garlic, broccoli and cabbage (Singh *et al*., 2006). Some antinutrients like tannins could exert beneficial biological activities such as antimicrobial, antiviral and antifungal (Nath *et al*., 2022; Singh *et al*., 2023). In addition, saponins suppress the absorption of alcohol, cholesterol and iron in the digestive system (Cao *et al*., 2024). Biologically, important phytochemicals such as oxalates, tannins, alkaloids, flavonoids and saponins are present in minimal amounts which are not likely to cause serious harm. Black seed, African nutmeg and negro pepper can be considered as a rich source of protein, lipids, energy and minerals (Ogunka-Nnoka and Mepba 2008). Some phytochemicals present in these ingredients such as oxalates, tannins, flavonoids, saponins and alkaloids might inhibit the bioavailability of minerals and vitamins (Akter *et al*., 2020) if present in high amounts. Aside from reducing the bioavailability of minerals in the body, oxalates also contribute significantly to kidney stones (Park, 2013). However, the amounts of antinutrients present in the ingredients are very minimal which might not cause serious harmful effects. Differences in the chemical compositions may be due to differences in soil characteristics and climatic conditions at the locations where the ingredients

were cultivated. They may also be due to growth conditions, genetic variations and differences in analytical procedures (Evuen 2022) **The phytobiotic potentials of the three ingredients (Black seed, African nutmeg and Negro pepper)**

Table 2: Minerals composition of Black seeds, African nutmeg and Negro pepper

Parameters (%)	Black seed	African nutmeg	Negro pepper
Sodium	0.02 ± 0.00	0.09 ± 0.00	0.11 ± 0.00
Potassium	0.31 ± 0.00	0.21 ± 0.00	0.43 ± 0.01
Calcium	0.79 ± 0.01	0.18 ± 0.00	0.28 ± 0.00
Magnesium	0.35 ± 0.01	0.19 ± 0.00	0.28 ± 0.00
Phosphorus	0.62 ± 0.00	0.35 ± 0.01	0.37 ± 0.01
(mg/kg)			
Iron	141.74 ± 0.11	57.27 ± 0.03	85.31 ± 0.07
Manganese	13.47 ± 0.02	17.67 ± 0.02	21.17 ± 0.03
Zinc	21.06 ± 0.02	26.19 ± 0.02	32.44 ± 0.05
Selenium	0.03 ± 0.00	0.02 ± 0.00	0.06 ± 0.00
Copper	5.81 ± 0.01	6.60 ± 0.00	8.00 ± 0.00

Table 3: Phytochemical composition of Black seeds, African nutmeg and Negro pepper

Parameters (%)	Black seed	African nutmeg	Negro pepper
Alkaloids	0.32 ± 0.01	0.19 ± 0.00	0.48 ± 0.02
Flavonoids	0.01 ± 0.00	0.02 ± 0.00	0.04 ± 0.00
Saponin	0.21 ± 0.00	0.16 ± 0.00	0.32 ± 0.01
Tannin	0.05 ± 0.00	0.02 ± 0.00	0.03 ± 0.00
Oxalates	0.03 ± 0.00	0.03 ± 0.00	0.07 ± o.00

Conclusion

Herbs are used in poultry and other livestock diets to produce a wide range of biological activities like antibacterial, anti-fungal, antiviral, anti-parasite and anti-coccidiosis. The outcome of the chemical screening in this study showed that black seeds, African nutmeg and Negro pepper could serve as phyto-additives in livestock diets that could enrich the antioxidant capacity of animals due to the presence of valuable nutrients in adequate proportion.

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