INFLUENCE OF HYDROTHERMAL TREATMENT DURATION ON THE NUTRITIONAL QUALITY OF AVOCADO PEAR (*PERSIA AMERICANA*) SEED MEAL FOR LIVESTOCK FEEDING

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ABSTRACT

The effect of different boiling time durations on the nutritional and bioactive compositions of avocado pear (Persea americana) seeds were investigated. The fruit was sourced from a local market, the ripe fruit pulp was eaten and the seed extracted and cleaned. Seeds were then chopped into smaller sizes and divided into five equal portions. Four parts were subjected to boiling at 15, 30, 45 and 60 minutes respectively and the fifth part was labelled raw (control). They were then dried, pulverized and analyzed for proximate, mineral and bioactive compositions. Results showed significant (p<0.05) reduction in the fibre fractions, bioactive compounds as the boiling time increased when compared with the raw. Although, the mineral concentrations did not follow similar pattern, but iron was observed to be significantly (p<0.05) higher in the treated samples than the raw. The energy values showed slight increase from the raw (15.76MJ/Kg) to 16.87MJ/Kg at 30 minutes hydrothermal treatment. It can therefore be concluded that hydrothermal treatment can significantly lower the bioactive and fibre contents of P. americana seeds to safe levels at the different boiling time investigated, hence, can be included in livestock feed.

Keywords: *Persea americana*, Bioactive, Hydrothermal, Nutritive, Livestock, Duration

INTRODUCTION

During the dry periods of the year, ruminant diets are limited by shortage in quantity and quality of available forage (Shelton, 2004), resulting in low milk and meat production. In recent times, non- conventional feed resources are gaining acceptance as feedstuff in livestock diets (Amata, 2010). These feed resources are incorporated in livestock diets as long as they do not have detrimental effects on the health status and production potentials of the animals. Among such is the avocado pear (*Persea americana)* seed. The avocado fruit belongs to the family of *Lauraceae* which includes approximately 150 species, majority of which are habitat of tropical America (Isiuku *et al*., 2009; Oluwole *et al.,* 2013). It is a well-known plant in Nigeria and it thrives well in the southern part of the country. The fruits are edible and the bark, leaves, stem and roots are used locally as tradomedicine against diseases (Waruhiu *et al*., 2004). The seed and skin are usually left as residues once the edible pulp is removed. The seed may be spherical, conical or elongated in shape and is found in the central cavity of the fruit. Kahn (1987) reported that avocados seeds are a potential source of starch containing about 30 %. However, the various natural compounds in-situ in seeds of plants can affect their nutritional quality, intake and utilization by livestock. Phytochemicals are also known as anti-nutrients or bioactive substances. They occur naturally in plants and contribute to the colour, flavor, smell of plants and serve as a natural defense mechanism against diseases (Eleazu *et al.,* 2012). The presence of these compounds has been shown to influence feed intake, digestibility and overall performance of the animals. However, it has been reported that majority of the anti-nutrients are thermolabile, therefore, a suitable heat treatment would

reduce or destroy them. The leaves of *P. americana* had been used in the feeding of goats (Chah and Igbokwe, 2011), also, the acceptability of diet with avocado pear seed had earlier been investigated (Okoruwa *et al.,* 2015). The thrust of this study is to investigate the nutrient and bioactive compositions of hydrothermally treated seeds to ascertain its suitability in livestock feeding.

MATERIALS AND METHODS

The study was conducted at the Ruminant Unit of the Teaching and Research Farm, Federal University of Technology, Akure, Nigeria. Akure is located on longitude 4.944055°E and 5.82864°E, and latitude 7.491780°N and 6.96375°N with annual rainfall ranging between 1300 mm and 1650 mm. Average maximum and minimum daily temperature of 38 °C and 27 °C in the wet season and 39 °C and 23 °C respectively (Daniel, 2015)

Avocado Seed Meal and Chemical Analysis: Ripe avocado pear fruits were purchased from Owena Market, Osun State, Nigeria. Fruits were cut open and the pulp eaten, the seeds were cleaned and chopped with sharp knife into small sizes. Chopped seeds were then divided into five parts (500 g each) to form each treatment. Four parts were labelled hydrothermally treated for 15, 30, 45 and 60 minutes respectively, while the fifth part was labelled raw and served as control. For the hydrothermally treated, each part was poured into 1000 ml of boiling water and allowed to cook at the specified durations using a hot plate. After boiling the hydrothermally treated and raw seed parts were air dried indoors to a constant weight. Thereafter, samples were pulverized using the hammer mill and stored in air tight containers until required for analysis. The proximate and mineral compositions were determined according to the methods of AOAC (1997), fibre fractions (Van Soest, 1985), phytate (Wheeler and Ferrel, 1971), tannin (Makkar and Goodchild, 1996), oxalate (Day and Underwood, 1986) and saponin (Brunner, 1984). All analyses were done in triplicates.

Statistical Analysis: Data obtained were analysed using one-way analysis of variance (ANOVA) of statistical analysis software SAS (9.2 version) (SAS, 2012) and means were separated using the Duncan Multiple Range Test of the same package.

RESULTS AND DISCUSSION

The chemical composition of the hydrothermally treated *P. americana* seed presented in Table 1 indicated that the dry matter ranged from 93.55 – 93.89 % for the treated samples, but were not significantly different ($p>0.05$). The protein contents were not significantly different ($p>0.05$) among the samples. However, a slight decrease which ranged from (1.15 – 1.39%) was observed in the crude protein content of the treated samples when compared with the raw (1.61%). Perhaps, this may be as a result of loss of soluble proteins into the boiling water of the hydrothermal treated samples (Lola, 2009). A similar observation was made by Adeparusi (2001) and Ndidi *et al*. (2014) with boiled Lima beans and Bambara groundnuts respectively. The values obtained is in agreement with the report of Isiuku *et al.* (2009) who obtained 1.24 % crude protein for African pear (*Dacryodes edulis*) seed and also within the range reported by Bora *et al.* (2001) for seeds of avocado but were lower than 3.36 and 4.44 % obtained by Oluwole *et al.* (2013) for unripe and ripe avocado seeds respectively.

The fibre (cell wall contents) fractions; NDF, ADF and ADL (62.52, 27.57 and 24.43 % respectively) of the raw avocado seeds were significantly higher ($p<0.05$) than the values of the heat treated samples. Though, the least values (35.34, 13.10 and 11.19 % for NDF, ADF and ADL respectively) were obtained in the 60 minutes treated seeds. This suggested that boiling avocado pear seed may improve the fibre content and its digestibility thereby promoting its use in livestock production. These findings are in tandem with the reports of Ndidi *et al*. (2014) for boiled Bambara groundnut and Obun and Ayanwale (2007) for roasted *Detarium microcarpum* seed meal.

Table 1: Chemical composition of raw and hydrothermally treated *Persea americana* seed

Parameters (%)	1 (15 mins)	2 (30 mins)	3 (45 mins)	4 (60 mins)	5 (Raw)
Dry matter	93.77±0.34	93.55±0.12	93.89±0.02	93.71±0.17	94.19±0.28
Ash	2.63±0.57^{b}	2.49±0.19^{b}	2.26±0.99^{b}	1.41±0.02^{bc}	3.59±0.08^{a}
Crude fibre	4.89±0.8^{b}	4.64±0.2^{b}	3.86±0.01^{bc}	3. 14±0.56^{bc}	6.15±0.94a
Ether extract	7.11±0.7^{b}	7.13±0.05^{b}	7.75±0.06^{b}	7.48±0.63b	8.56±0.67^{a}
Crude protein	1.39±0.67	1.28±1.15	1.22±0.59	1.15±1.33	1.61±0.87
Carbohydrate	6.48±0.53	6.71±3.44	6.54±1.70	6.32±5.23	6.13±1.91
Energy (MJ/kg)	16.65±0.02^{a}	16.87±0.02^{a}	16.76±0.02^{a}	16.06±0.01^{a}	15.72±0.01^{b}
Neutral detergent fibre	49.3±0.07^{b}	43.34±0.29^{b}	37.79±0.23^{c}	35.34±1.07^{c}	62.52±0.51^{a}
Acid detergent fibre	16.28±0.69^{b}	16.33±0.47^{b}	15.58±0.29^{bc}	13.10±0.63^{c}	27.57±1.27^{a}
Acid detergent lignin	22.22±0.67^{a}	19.18±0.87^{b}	15.41±0. 57^{c}	11.19±0.77^{d}	24.43±0.46^{a}

Mins = minutes, Mean values in the same row with different superscripts are significantly different at p<0.05.

Table 2: Mineral compositions of raw and hydrothermally treated *Persea americana* seed

Parameters (mg/g)	1 (15 mins)	2 (30 mins)	3 (45 mins)	4 (60 mins)	5 (Raw)
Iron	0.59±0.04^{c}	0.67±0.07^{b}	0.83±0.09^{a}	0.89±0.09^{a}	0.25±0.01^{d}
Magnesium	3.15±0.04^{a}	3.03±0.02^{a}	3.29±.0.02^{a}	2.70±0.01^{ab}	3.67±0.02^{a}
Sodium	12.30±0.42^{a}	10.90±0.32^{b}	8.60±0.11^{c}	8.01±0.11^{c}	8.80±0.22^{c}
Potassium	86.00±1.06^{d}	140.00±1.11^{b}	92.00±1.08^{c}	148.00±1.21^{b}	196.00±1.17^{a}
Calcium	2.50±0.01^{ab}	3.00±0.02^{a}	2.00±0.01^{b}	3.00±0.02^{a}	3.00±0.02^{a}
Nitrogen	2.21±0.02^{a}	1.65±0.01^{b}	2.24±0.02^{a}	1.93±0.01^{b}	2.20±0.02^{a}
Phosphorus	0.11±0.01^{b}	0.11±0.01^{b}	0.11±0.01^{b}	0.13±0.01^{a}	0.10±0^{c}

Mins = minutes, Mean values in the same row with different superscripts are significantly different at p<0.05.

Table 3: Bioactive compositions of raw and hydrothermally treated *Persea americana* seed

Parameters (mg/100g)	1 (15 mins)	2 (30 mins)	3 (45 mins)	4 (60 mins)	5 (Raw)
Saponin	14.11±3.24^{b}	12.53 ±0.63^{c}	11.88±0.21^{c}	10.83±0.15^{cd}	16.05±0.76^{a}
Alkaloid	3.95±0.14^{b}	2.06 ±0.87^{c}	1.29±0.25^{cd}	1.6±0.13^{cd}	6.34±0.15^{a}
Oxalate	3.38 ±0.14^{ab}	2.16 ±0.18^{b}	1.89±0.63^{c}	1.44 ±0.9^{c}	3.92 ±0.86^{a}
Phytate	14.42 ±1.24^{b}	11.54 ±0.83^{c}	10.35 ±0.41^{cd}	10.37 ±1.24^{cd}	23.07±0.83^{a}
Flavonoid	10.08±0.05^{b}	7.28±0.17^{c}	6.16 ±0.19^{cd}	6.16 ±0.03^{cd}	12.61±1.34^{a}
Tannin	0.03±0.01^{b}	0.02±0.01^{c}	0.02±0.01^{c}	0.02±0.01^{c}	0.04±0.01^{a}

Mins = minutes, Mean values in the same row with different superscripts are significantly different at p<0.05.

The ash content is significantly important in foods as they account for the mineral constituents but must not be too much (Oluwole *et al*., 2012). The ash content was observed to be higher in the raw seed (3.59 %) than in the hydrothermal treated seeds (1.41-2.63 %). This difference could be due to leaching of some minerals in the water during boiling (Hefnawy, 2011).

Carbohydrate which represents a source of energy to the body did not show significant difference (p>0.05) among the samples. Values ranged between 6.32 – 6.71 % for treated seeds and 6.13 % for raw seeds. This implied that the varying duration of heat treatment did not influence the carbohydrate content of the seeds. These values were slightly higher than 4.67 % reported by Oluwole *et al*. (2013) for ripe avocado pear seed and lower than 15.74 % for unripe avocado seed. It was observed that the raw seed sample had the lowest energy value of 15.72 MJ/KG compared to the treated seed samples which ranged from 16.05 – 16.87 MJ/KG.

The heat treatment seemed to have increased the energy slightly in the boiled seeds. This finding is at variance with the report of Ndidi *et al*. (2014) who reported a reduction in energy in boiled Bambara groundnut. However, the non-significant difference ($p>0.05$) observed among the boiled samples implies that duration of boiling did not affect the energy content of the seeds.

Significant differences ($p<0.05$) were observed in the mineral contents among the raw and treated avocado seeds (Table 2). Increase in Iron and phosphorus concentrations were observed in treated seeds when compared with the raw. This suggested that iron was not easily leached by boiling. This agreed with the findings of Ndidi *et al.* (2014) for boiled Bambara groundnuts.

Anti-nutritional compounds in feed are lethal to animals if consumed beyond their tolerable levels and may have negative effects on mineral bioavailability. All the bioactive compounds determined in this study were observed to be significantly higher ($p<0.05$) in the raw seeds and lowest in the 60 minutes treated samples (Table 3). This indicated that boiling may significantly reduce anti-nutrients in feed materials. This confirmed to the reports of Nyachoti *et al.* (1997), Lola (2009) and Ndidi *et al.* (2014). However, the level of tannin was observed to be relatively lower when compared to other anti-nutrients. The low levels of bioactive compounds observed in treated samples may be due to their solubility in boiling water. The concentrations of phytochemicals in this study were lower than the values (tannins 21.26 %, saponins 51.00 %, flavonoids 21.00 % and alkaloids 9.43 %) obtained by Nwaoguikpe *et al.* (2011) for avocado seed extracts. The variation may be due to variety differences, nature of the seeds (unripe or ripe) and the differential effect of boiling on the seeds.

Conclusion: Hydrothermal treatment had significant effect in the reduction of fibre fractions and bioactive compounds in avocado seeds. Slight reduction in some of the mineral contents were observed in the treated seeds, however, there was no total leaching of the minerals considered. Also some mineral concentrations were improved by the heat treatment. However, the 60 minutes hydrothermal treatment was most effective in the reduction of the bioactive compounds. This therefore suggests that avocado seeds when treated (boiled) may be incorporated in livestock feed as energy and mineral sources.

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