Nutritional potential of raw or parboiled Siam weed (Chromolaena odorata) leaves as feedstuff for finishing broilers

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Abstract

A study was conducted using ninety finishing broiler chickens to determine the nutritional potentials of air-dried fresh and parboiled air-dried siam (*Chromolaena odorata*) leaves harvested lush green. The first set of leaves was air-dried with minimal sun rays and designated as fresh air-dried *Chromolaena odorata* leaves (FADCOL). The second set of leaves was parboiled for 10 minutes at 80^{o}C before air-drying with minimal sun rays and was designated as parboiled air-dried *Chromolaena odorata* leaves (PADCOL). Both sets of processed leaves were subjected to proximate analyses. A standard broiler finisher diet formulated was used as the control dietary treatment. In the second and third treatments, 20% of the standard broiler finisher diet was replaced by FADCOL and PADCOL, respectively. Each treatment group was replicated in three places of ten broiler chickens. Nutrient retention trials were carried out using total collection method. Results showed that parboiled air-dried *Chromolaena odorata* leaves had numerically higher crude fat and fibre contents but lower crude protein and total ash content than the fresh samples. There were no significant differences in crude protein, crude fibre and total ash retentions among finishing broilers fed various test diets ($p > 0.05$). However, the dry matter and crude fat retentions were significantly influenced by dietary treatments ($p < 0.05$). With the comparable crude protein retention, it was concluded that *Chromolaena odorata* leaves, whether air dried as harvested or parboiled before air drying, had the potential for supporting growth in finishing broilers.

INTRODUCTION

Many plants are directly or indirectly useful to humans. Some of these plants' leaves, stem barks, root barks, and tuberous roots are directly taken as food (Nag and Nag, 2022). The medicinal values of many of these plants cannot be overemphasized. One such medicinal plant is siam weed (*Chromolaena odorata*). This plant was formerly botanically referred to as *Eupatorium odoratum.* Its medicinal values have been somewhat eclipsed by the notoriety it earned as a very 'obnoxious weed' because of its ability to infiltrate new lands (Hu et al., 2023; Kantha et al., 2023). The plant grows quickly and forms dense and impregnable foliage that can completely smother a young plantation of crops or weeds (Etejere, 1979). The use of *Chromolaena odorata* leaves in livestock nutrition has been kept abeyance partly because of the death reported in cattle that consumed the leaves in the fresh form (Aro et al., 2009). The plant, however, has some useful properties as an antispasmodic, antiprotozoal, antitrypanosomal, diuretic and hepatotropic agent (Akinmoladun et al., 2007; Igbho et al., 2009). As reported by the various authors, the nutrient contents of Chromolaena odorata leaves vary greatly. For example, Anyasor et al. (2011) reported 15% moisture, 14.9% fibre, 10.75% crude fat, 18.37% crude protein, 10.5% ash and 30.48% carbohydrate. On the other hand, Ekeyem *et al.* (2010) reported 8.65% moisture, 10.07% crude fibre, 16.67% crude protein, 8.58% ash, 1.87% ether extract and 54.47% Nitrogen Free Extract. Furthermore, Bamikole et al. (2004) reported 85.9% dry matter, 89.65% organic matter, 29.76% crude protein, 10.75% crude fibre, 1.48% ether extract, 47.42% NFE and 10.35% ash. Moses et al. (2010) subjected sundried *Chromolaena odorata* leaves to hydro-distillation for four hours and reported that the light green essential oil extracted when subjected to gas chromatography and mass spectrometry contained 56 essential components among which are α and β – pinenes, representing 42.2% and 10.6% respectively.

Results of studies with *Chromolaena odorata* leaves usage in animal feeding have not been consistent. Akinmitimin and Akufo (2006) reported a significant reduction in feed intake when the plant leaves were fed to growing rabbits. Bamikole et al. (2004) reported that the plant leaves could be fed up to 30% of the dry matter without compromising weight gain, feed conversion efficiency and feed digestibility in feeding rabbits. Aro (1990) tested the utilization of sundried *Chromolaena odorata* leaves in layers diet and reported no adverse effects on feed consumption, feed efficiency, total egg production, percentage hen day production and mortality. However, the leaves were fed at a 7.5% maximum inclusion level. Ekeyem *et al.* (2010) reported that when *Chromolaena odorata* was used in finishing broiler diet to replace soybean meal, a 5% inclusion level was optimum for comparable feed intake, weight gain and feed conversion ratio. The need to reduce the ever-increasing cost of poultry feeding has continued to make it imperative that concerted research efforts be continuously made to use non-conventional but relatively available feed ingredients. For *Chromolaena odorata* leaves to be made suitable for livestock feeding, some form of processing might be necessary to remove the inherent anti-nutritional factor, such as carcinogenic pyrrolizidine alkaloids, which have been reported to be toxic to cattle (Gunasekera, 2009).

Heat treatment, whether dry or wet, is one of the methods used for processing potential feed ingredients without affecting the nutritional integrity of the feedstuffs; as it increases feed intake, digestibility, improves feed conversion and reduces feed waste (Gurbuz, 2017). Heat Treatment has successfully reduced microbial loads, improved fresh-cut products' quality and shelf life, reduced chilling injury, and retained texture (Barry-Ryan, 2012). Gurbuz (2017) reported that thermal processing methods improve animal feed's nutritional, hygienic, physical and chemical properties. The most commonly used heat processing methods in the world are pelleting, extrusion, expanding, steam flaking, conditioning, cooking, micronization, roasting, toasting and popping (Jansen, 1991; Abdollahi et al., 2013; Gurbuz, 2017).

This study sets out to determine, among many other things, the extent to which either simple drying or a combination of parboiling and drying would affect the nutrient content of *Chromolaena odorata* leaves. Since the amount of nutrients retained from a given nutrient intake by an animal, to a large extent, determines the subsequent performance of such animal, this study also sets out to determine the effect of replacing 20% of finishing broiler chicken feed with treated *Chromolaena odorata* leaves on their nutrient retention.

MATERIALS AND METHODS

A total of ninety (90) five-week-old broiler chickens of mixed sex previously raised on similar diets were used to assess the nutritional value of fresh air-dried and parboiled air-dried *Chromolaena odorata* leaves. The birds were housed in colony metabolic cages suitable for total excreta collection. The study was carried out at the Teaching and Research Farm of the University of Benin.

Chromolaena odorata leaves harvested lush green were processed in two sets. The first leaf set was air-dried on an open platform with minimal sun rays and designated as fresh air-dried *Chromolaena odorata* leaves (FADCOL). The second set of leaves was parboiled for 10 minutes at 80^{o}C before air drying on an open platform with minimal sun rays and was designated as parboiled air-dried *Chromolaena odorata* leaves (PADCOL). The leaves were milled before use. Both sets of processed leaves were subjected to proximate analyses. A standard broiler finisher diet formulated (Table 1) was used as the control dietary treatment. In the second and third treatments, 20% of the standard broiler finisher diet was replaced by FADCOL and PADCOL, respectively. Each treatment group was replicated in three places of ten broiler chickens. After a week of diet adjustments, nutrient retention trials were carried out using total collection method. At the end of the three-day collection period, the excreta collected were wrapped up and dried in a Gallenhamp oven set at 80^{o}C until properly dried. The respective dried excreta were weighed and milled for proximate analyses. Proximate analyses of the *Chromolaena odorata* leaves, diets, and excreta were carried out using AOAC (2000).

Nutrient retention for each nutrient was calculated using the formula:

Nutrient retained = Nutrient Intake - Nutrient in faeces

Table 1
Composition of the basal finisher diet

Ingredient	**% composition**
Maize	59.70
Soybean meal	31.00
Palm kernel meal	3.00
Wheat bran	2.00
Bone meal	2.50
Limestone	1.00
Salt	0.35
*Premix	0.25
Methionine	0.10
Lysine	0.10
Total	**100**
Proximate Composition of diet (calculated)	
Nutrient	% Composition
Dry matter	86.22
Crude Protein	17.50
Ether Extract	21.80
Crude Fibre	3.40
Ash	5.93
Nitrogen free extract	51.36
M.E (calculated)	2956 kcal/kg

*Provide the following per kg of diet: Vitamin A, 10000iu; Vitamin D_3 2000iu; Vitamin E, 5iu; Vitamin K, 2mg; Riboflavin, 4.20mg; vitamin B_{12}, 0.01mg; Pantothenic acid, 5mg; Nicotinic acid; Folic acid, 0.5mg; Chlorine, 3mg; Mg, 56mg; Fe, 20mg; Cu, 10mg; Zn, 50mg; Co, 25mg; Iodine, 0.8mg.

RESULTS

The proximate compositions of the fresh air-dried *Chromolaena odorata* leaves, and the parboiled air-dried *Chromolaena odorata* leaves are shown in Table 2. Fresh air-dried *Chromolaena odorata* leaves (FADCOL) were higher in crude protein (26.25%) and total ash (7.84%) contents. On the other hand, parboiled air-dried *Chromolaena odorata* leaf (PADCOL) was higher in crude fat (9.65%), crude fibre (29.60%) and Nitrogen free extract (36.48%) contents.

Table 2
Proximate composition of *Chromolaena odorata* leaves

	Dry matter%	Crude Protein%	Crude Fat%	Crude Fibre%	Total Ash%	NFE
FADCOL	86.33	26.25	7.00	26.20	7.84	32.70
PADCOL	86.53	21.00	9.65	29.60	3.27	36.48
FADCOL: Fresh air-dried *Chromolaena odorata* leaves						
PADCOL: Parboiled air-dried *Chromolaena odorata* leaves						
NFE: Nitrogen Free Extract						

The effects of replacing 20% of the broiler finisher diet with either FADCOL or PADCOL on nutrient retention of broiler chickens are shown in Table 3. Both the dry matter and crude fat retentions were significantly influenced by dietary *Chromolaena odorata* leaves ($p < 0.05$). The lowest dry matter retention value (96.67%) and crude fat retention value (76.0%) were obtained among broiler chickens fed parboiled air-dried *Chromolaena odorata* leaves (PADCOL). However, dry matter and crude fat retention values were similar for the fresh air-dried *Chromolaena odorata* leaves (FADCOL) and the unsubstituted (control) finisher diet. Crude protein and total ash retentions were similar among broiler chickens regardless of the dietary treatments ($p > 0.05$).

Table 3
Effects of replacing 20% of finisher diets with *Chromolaena odorata* leaves on the nutrient retention of broiler chickens

	TREATMENT			
Parameter	**Finisher diet**	**20% FADCOL**	**20% PADCOL**	**SEM**
Dry matter %	98.00^{a}	97.33^{ab}	96.67^{b}	0.27
Crude Protein %	70.30^{a}	82.30^{a}	76.00^{a}	5.90
Crude Fat %	91.00^{a}	84.70^{ab}	76.00^{b}	3.79
Crude Fibre %	57.70^{a}	42.00^{a}	42.70^{a}	7.09
Total Ash %	25.30^{a}	46.00^{a}	37.70^{a}	8.94

Within rows, means carrying different superscripts are significantly different ($p < 0.05$)

FADCOL - Fresh air dried *Chromolaena odorata* leaves

PADCOL - Parboiled air-dried *Chromolaena odorata* leaves

SEM - Standard Error of Mean

DISCUSSION

The treated leaves were reduced in crude protein and ash content. While the crude protein of the fresh *Chromolaena odorata* leaves was 26.25% that of the parboiled leaves was 21.0%. The fresh *Chromolaena odorata* leaves also recorded a higher ash value of 7.84% compared to the heat-treated leaves, which had a value of 3.27%. Presumably, the reduction in the crude protein and ash content of the parboiled leaves was due to the wet heat treatment to which the leaves were subjected. Some parts of the organic component of the leaves may have been lost in the water through leaching during the boiling process. The reduced crude protein of the wet heat-treated leaves may be because some of the nitrogenous/protein compounds in the leaf dissolved in the water during the heating process. However, the crude protein value obtained from this study for the fresh *Chromolaena odorata* leaves, 26.25%, was higher than the value reported by Bamikole et al. (2004); Fasuyi et al. (2005); Akinmutimi and Akufo (2006) and Anyasor et al. (2011). The fresh *Chromolaena odorata* leaves also recorded a higher ash value of 7.84% compared to the parboiled leaves, which had a value of 3.27%. The reason for this variation in the protein content of the leaves, as reported, may be due to the differences in time/season of harvesting the leaves, the age of the plant at the time of harvesting the leaves, the accuracy of the analytical method used, the type of fertilizers that have been previously used in the soil because a soil to which nitrogenous fertilizer has been applied will grow plant rich in protein. On the other hand, both the crude protein and ash contents of *Chromolaena odorata* leaves recorded in this study are comparable with values reported by Nworgu and Egbunike (2013), who concluded that leaf meals are rich in crude protein (21.36% – 23.34%) and ash (4.23% – 9.14%).

The reduction in the crude protein of the parboiled leaves accompanied an increase in the crude fibre content. The fibre content of the raw leaves was 26.20% lower than that of the parboiled leaves, which was 29.60%. This is in line with the report of Ekenyem et al. (2010) that the crude protein and the crude fibre of the unconventional leaves show a negative correlation because, with an increase in one parameter, there is a decrease in the other. The ether extract value for both fresh and parboiled *Chromolaena odorata* leaf meal ranged from 7.0 to 9.65%. This indicates that *Chromolaena odorata* leaves contain some oil that could furnish some metabolizable energy into formulated diet of finishing broilers.

The insignificant retention values for crude protein and ash, as observed in this when *Chromolaena odorata* leafmeal-based diets were compared with the undiluted finisher diet, could imply that whether fed the diet containing either fresh or heat-treated, the protein and minerals made available to the animal for metabolic activities will not be altered. It may be reasoned that *Chromolaena odorata* leafmeal could be used to support growth in broilers since protein is the required nutrient for growth, and minerals are needed for bone development and maintenance.

In conclusion, undoubtedly, the exploitation of underutilized feed ingredients such as *Chromolaena odorata* and other leafmeal is likely to continue in an effort to ameliorate the rising cost of livestock feed. However, apart from the likelihood of some of these leaf materials containing some anti-nutritive substances, their high fibre contents also represent the major constraints for their use for monogastric animals. This is not without a solution. Proper processing, such as sun drying or some heat treatment, will help remove certain anti-nutritive factors. Furthermore, using exogenous enzymes as is currently being practiced will help make the inherent nutrients in leaf meal available to non-ruminant animals such as broiler chickens. Therefore, processed *Chromolaena odorata* leaf meal can be used at 20% substitution in finishing broiler diets.

Declarations

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Both authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Philemon Ogieriakhi and Johnson Oyedeji. The first draft of the manuscript was written by Philemon Ogieriakhi, and Johnson Oyedeji commented on previous versions of the manuscript. Both authors read and approved the final manuscript.

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

The ethics governing the use and conduct of experiments on animals were strictly observed, and the experimental protocol was approved by the Department of Animal Science, University of Benin. No written approval of research ethics committees was required to accomplish the goals of this study.

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