Pertanika J. Trop. Agric. Sci. 25(2): 87 - 91 (2002)
ISSN: 1511-3701

Proximate Composition of Seeds of Some Lesser-Known Crops

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Keywords: Nutritive quality evaluation, *Jatropha curcas, Trichosanthes cucumerina, Annona muricata, Citrullus vulgaris*

ABSTRAK

Biji benih Jatropha curcas, Trichosanthes cucumerina, Annona muricata *dan* Citrullus vulgaris *dianalisis untuk komposisi proksimat, karbohidrat dinding sel, komponen nutrien dan bukan nutrien, kemudian nilai tenaga kesemuanya dianggarkan. Biji benih tanaman mengandungi per kg: 113.1 – 324.5 g protein kasar, 364.8 – 483.3 g lemak, 29.3 – 296.8 g fiber kasar, 29.8 – 37.8 g abu tatal, 111.9 – 222.8 g karbohidrat larut, 41.0 – 363.4 g karbohidrat dinding sel, 18.0 – 169.0 g selulos, 23.9 – 194.4 g hemiselulos, 706.5 – 970.7 g jirim sel, 685.3 – 947.0 g jirim sel organik, 10.4 – 29.6 abu larut, 5.2 – 19.4 g abu tidak larut asid, 25.5 – 39.4 g jirim bukan nutrien dan 20.0 – 48.6 g lignin, 19.2 – 25.6 MJ tenaga total, 9.0 – 21.9 MJ tenaga badan muricata, semua sampel biji benih berpotensi sebagai sumber yang baik untuk tenaga data tambahan protein bagi ruminan. Keperluan untuk mengkaji dengan lebih lanjut juzuk elemen mineral dalam memastikan kecukupan atau sebaliknya yang dapat memenuhi keperluan haiwan adalah disyorkan.*

ABSTRACT

Seeds of Jatropha curcas, Trichosanthes cucumerina, Annona muricata *and* Citrullus vulgaris *were analysed for proximate composition, cell wall carbohydrates, nutritive and non-nutritive components and then their energy values were estimated. Crop seeds contained per kg: 113.1 – 324.5 g crude protein, 364.8 – 483.3 g fat, 29.3 – 296.8 g crude fibre, 29.8 – 37.8 g total ash, 111.9 – 222.8 g soluble carbohydrate, 41.0 – 363.4 g cell wall carbohydrate, 18.0 – 169.0 g cellulose, 23.9 – 194.4 g hemicelluloses, 706.5 – 970.7 g cellular matter, 685.3 – 947.0 g organic cellular matter, 10.4 – 29.6 g soluble ash, 5.2 – 19.4 g acid-insoluble ash, 25.5 – 39.4 g non-nutritive matter, 20.0 – 48.6 g lignin, 19.2 – 25.6 MJ total energy, 9.0 – 21.9 MJ digestible energy and 66.5 – 269.4 g digestible crude protein. It was concluded that except for* Annona muricata, *all the seed samples are potentially good sources of dietary energy and protein supplements for ruminants. The need to further investigate the inorganic matter for their mineral element constituents in order to ascertain adequacy or otherwise in meeting the animal requirement is suggested.*

INTRODUCTION

Smallholder producers of ruminants, particularly sheep and goats in Nigeria, rely on unimproved natural pasture as the main feed source, backed up with crop residue after harvest. The animals are confined, tethered or closely herded during the crop growing season, but graze and browse more freely once the food crop has been harvested. This problem of inadequate nutrition is further aggravated particularly in the dry season when grassland productivity is low. Supplementary feeding with either concentrates or browse plants has been advocated as a remedy for improving the animals' nutrition (Reynolds and Jabbar 1994). Indeed, Reynolds and Ekurukwe (1988) noted that protein-rich supplements improved the nutrition of sheep in smallholder grass-based systems and increased resistance to diseases such as trypanosomiasis, but farmers do not have access to the feed or are unwilling to spend cash on supplements. Use of cheaper, lesser-known and unconventional feed

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supplements may represent the low-cost route to improved animal performance. In this regard, many attempts have been made to evaluate the chemical composition and nutritional potential of some common legumes and browse plants as feed supplements (Akinsoyinu and Onwuka 1988; Alawa *et al.* 1990; Oduguwa *et al.* 1997). The present study reports on the chemical evaluation of nutrient content and energy values of seeds of *Jatropha curcas, Trichosanthes cucumerina, Annona muricata and Citrullus vulgaris,* and the information is intended to serve as a prerequisite for further investigating their feeding value and use as concentrate supplements in sheep feeding.

MATERIALS AND METHODS

Seeds were carefully extracted from freshly harvested matured and ripened fruits of *Jatropha curcas, Trichosanthes cucumerina, Annona muricata and Citrullus vulgaris,* sun-dried for 72 h and then mechanically shelled to obtain the kernels. The kernels were oven dried at 80°C for 48 hrs and then ground in a warring mill to produce flours that passed through an 80-mesh sieve.

Three replicate samples of the respective flours were analysed for protein (%N multiplied by 6.25), fat, crude fibre and total ash (AOAC 1990). Carbohydrate (nitrogen free extractives) was obtained by difference. Total energy was estimated using the modified Atwater factor as follows: total energy of seed (kcal/100g) = (protein (g) x 4) + (fat (g) x 9) + (carbohydrate (g) x 1.1 x 3.75) (Hunt *et al.* 1987). Total ash was fractionated into acid-soluble and acid-insoluble fractions (Egan *et al.* 1981). Organic cellular content, cell wall carbohydrates (cellulose and hemicelluloses), lignin, nutritive and non-nutritive matters were determined and data were fitted into prediction equations to obtain digestible energy values for sheep (Southgate 1969; Fonnesbeck 1976). Digestible crude protein was estimated as follows: digestible crude protein (g) = (Protein (g) x 0.96) – 4.21(Barrett and Larkin 1977).

The data were subjected to an analysis of variance (ANOVA) by the procedures of Steel and Torrie (1960). Significant treatment means were separated by the multiple range test of Duncan (1955).

RESULTS AND DISCUSSION

The results of proximate composition (Table 1) indicated that with the exception of total ash contents, the crop seeds varied significantly in their nutrient contents and the estimated total energy values. The least protein content (113.1 g/kg) was found in *Annona muricata,* while *Trichosanthes cucumerina* had the highest (324.5 g/kg). However, no marked difference in protein content existed among *Trichosanthes cucumerina, Jatropha curcas and Citrullus vulgaris,* and they are superior to groundnut (272.0 g/kg), cotton seed (285.0 g/kg), sunflower seed (160.0 g/kg) and coconut seed (110.0 g/kg) that constituted raw materials for production of the conventional protein concentrates (oilseed meals) in ruminant feeding in Nigeria (Oyenuga 1968). In addition, they contain more protein than the foliages of *Afzelia africana* (117.0 g/kg), *Albizia zygia* (192.0 g/kg), *Baphia nitida* (125.0 g/kg), *Cassia siamea* (196.0 g/kg), *Delonix regia* (133.0 g/kg), *Parkia biglobosa* (121.0 g/kg), *Samanea saman* (177.0 g/kg), *Caesalpinia*

TABLE 1
Proximate composition and total energy values of seed samples

Seed samples	Protein (g/kg)	Fat (g/kg)	Crude fibre (g/kg)	Total ash (g/kg)	Carbohydrate (g/kg)	Total energy (MJ/kg)
Jatropha curcas	315.8^{a*}	364.8^{b}	60.4^{b}	29.8	222.8^{a}	22.9^{b}
Trichosanthes cucumerina	324.5^{a}	483.3^{a}	48.8^{b}	34.8	111.9^{c}	25.6^{a}
Annona muricata	113.1^{b}	381.0^{b}	296.8^{a}	32.7	173.1^{b}	19.2^{c}
Citrullus vulgaris	307.4^{a}	474.2^{a}	29.3^{c}	37.8	151.3^{b}	25.6^{a}
± SEM**	50.8	30.8	63.0	1.7	23.1	1.5

*Mean values followed by different superscripts in a column are significantly different (P<0.05).
**Standard error of the mean.

pulcherrima (143.0 g/kg), *Cassia mimosoides* (155.0 g/kg), *Desmodium velutinum* (157.0 g/kg), *Flemingia macrophylla* (147.0 g/kg), *Tephrosia bracteolata* (178.0 g/kg) and *Tephrosia densiflora* (144 g/kg) earlier recommended as good supplements for ruminant feeding (Oduguwa *et al.* 1997).

All the crop seeds analysed in this study contained appreciable amounts of fat ranging from 364.8 g/kg in *Jatropha curcas* to 483.3 g/kg in *Trichosanthes cucumerina.* While no marked difference existed between each of the pairs of *Jatropha curcas* and *Annona muricata* and of *Trichosanthes cucumerina* and *Citrullus vulgaris,* the latter pair had a significantly higher fat content. All samples contained about 8 – 9 times the average fat content (410.0 – 520.0 g/kg) of the recommended foliages (Oduguwa *et al.* 1997). Fat content of the seeds falls within the range reported by Oyenuga (1968) and Godin and Spensley (1971) : for groundnut (509.0 g/kg), soybean (191.0 g/kg), cottonseed (141.0 g/kg), coconut seed (659.0 g/kg) and sunflower seed (334.0 g/kg). Indeed extraction of oils from the crop seeds prior to use as supplements will further increase their nutrient densities, and hence boost their value as alternative feed supplements with lower cost advantage.

The crude fibre is highest in *Annona muricata* (296.8 g/kg) and lowest in *Citrullus vulgaris* (29.3 g/kg). All the seeds excepting *Annona muricata* contained lesser amounts of crude fibre than foliages of crops species (178.0 – 193.0 g/kg) earlier recommended as supplements for ruminant feeding (Oduguwa *et al.* 1997). On the other hand, carbohydrate content, which ranged from 111.9 g/kg (*Trichosanthes cucumerina*) to 222.8 g/kg (*Jatropha curcas*) for the seeds analysed are less than the average (466.0 g/kg) found in the recommended supplements (Oduguwa *et al.* 1997). The nutritional implication for using the crop seeds, as feed supplement is that the bulk of the total feed calories will come from the fat component. Indeed, total energy values for seeds analysed indicated that *Trichosanthes cucumerina* and *Citrullus vulgaris* that contained significantly higher fat content had more total energies (25.6 MJ/kg) than those contained in *Annona muricata* (19.2 MJ/kg) and in *Jatropha curcas* (22.9 MJ/kg).

In terms of feeding value, crude fibre is intended as a measure of the quantity of the fibrous and poorly digested material in the feed. Therefore, the amount of crude fibre in the feed is excluded when estimating total feed energy. On the contrary, there is ample evidence supporting the fact that digestibility of dietary carbohydrate does not follow its partition into crude fibre and soluble carbohydrate (Nitrogen free extractives, NFE) with a marked certainty (Fonnesbeck 1976). Consequently, the author suggested partitioning crude fibre into partially nutritive components (cellulose and hemicellulose) and non-nutritive components (lignin, non-nutritive matter and acid insoluble ash). The less fibrous nature of *Citrullus vulgaris, Trichosanthes cucumerina* and *Jatropha curcas* might be advantageous when their seeds are used as feed supplements in a ruminant feeding regime that is grass-based in that substantial amounts of the nutrients they contain are in the form of cellular matter (i.e. the nutritive component). Indeed, the results in Table 2 indicated that there was no significant difference between the

TABLE 2
Nutritive, partially nutritive and non-nutritive components of seed samples

Constituent	Seed samples				± SEM**
	Jatropha curcas	*Trichosanthes cucumerina*	*Annona muricata*	*Citrullus vulgaris*	
Nutritive components:					
Cellular matter (g/kg)	939.5[a*]	967.9[a]	706.5[b]	970.7[a]	63.6
Organic cellular matter (g/kg)	929.2[a]	938.4[a]	685.3[b]	947.0[a]	63.3
Soluble ash (g/kg)	10.4[c]	29.6[a]	21.9[b]	23.7[a]	4.0
Partially nutritive components:					
Cell wall carbohydrate (g/kg)	84.9[b*]	73.0[b]	363.4[a]	41.0[c]	74.9
Cellulose (g/kg)	36.2[b]	32.5[b]	169.0[a]	18.0[b]	35.2
Hemicellulose (g/kg)	49.5[b]	40.5[b]	194.4[a]	23.9[b]	39.5
Non-nutritive components					
Acid-insoluble ash (g/kg)	19.4[a]	5.2[d]	10.8[c]	14.1[b]	3.0
Lignin (g/kg)	20.0[b]	20.3[b]	48.6[a]	21.9[b]	7.0
Non-nutritive matter (g/kg)	39.4[b]	25.5[c]	59.4[a]	36.0[b]	7.1

*Mean values followed by different superscripts in a row are significantly different ($P<0.05$).
**Standard error of the mean.

cellular matter contents of *Citrullus vulgaris*, *Trichosanthes cucumerina* and *Jatropha curcas*, but that they are superior to *Annona muricata* in this regard. A similar trend was observed in the case of organic cellular matter.

Characteristically, ruminants raised in smallholder grass-based systems in Nigeria derived their mineral intake from forage and supplemental common salt in the form of salt lick (Akinsoyinu and Onwuka 1988). This problem of inadequate mineral intake was further aggravated by reduced mineral availability due to high dietary fibre intake, which was believed to interfere with their absorption in the gut (Best 1993). This therefore underscores the need to fractionate the total ash into acid-soluble and acid-insoluble fractions as the basis of bioavailability. The results showed that the latter was more than the former in *Jatropha curcas*, and the reverse was the case for the rest of the seeds (Table 2). Non-nutritive matter, a combination of lignin and acid-insoluble ash, was highest (59.4 g/kg) in *Annona muricata* and least (25.5 g/kg) in *Trichosanthes cucumerina*. Lignin content ranged from 20.0 g/kg in *Jatropha curcas* to (59.4 g/kg) in *Annona muricata*.

The partially nutritive component, the cell wall carbohydrate, was fractionated into cellulose and hemicellulose and the results are shown in Table 2. The fractions were remarkably higher in *Annona muricata* than in the rest of the seeds. The ranges for cell wall carbohydrate, cellulose and hemicellulose were 41.0 – 363.4 g/kg, 18.0 – 169.0 g/kg and 23.9 – 194.4 g/kg in that order. The significantly higher fibrous nature, coupled with the higher non-nutritive components in *Annona muricata* might limit utilisation of its nutrients by the animal and hence reduce the energy derivable from the seed.

Results in Table 3 indicated that estimated digestible energy of seeds ranged from 9.0 MJ/kg in *Annona muricata* to 21.9 MJ/kg in *Citrullus vulgaris*. Digestible energy (% total energy), an indication of the extent to which feed energy is digested, tended to suggest that *Annona muricata* might be a poor (46.9%) energy source for the animal. While *Trichosanthes cucumerina* could be marginal (76.0%), *Jatropha curcas* and *Citrullus vulgaris*, with digestibility values of 87.9% and 85.5% respectively, might be good energy sources. Digestible energy values of all the seeds analysed, excepting *Annona muricata*, are higher than those of groundnut cake (16.0 MJ/kg), soybean meal (15.8 MJ/kg), cotton seed meal (13.0 MJ/kg), coconut meal (13.8 MJ/kg) and linseed meal (15.0 MJ/kg) that are some of the conventional protein concentrates in ruminant feeding (Barrett and Larkin 1977). Estimated digestible crude protein ranged from 66.5 g/kg to 269.4 g/kg with the least occurring in *Annona muricata* and the highest in *Trichosanthes cucumerina* (Table 3). With the exception of *Annona muricata*, all the seeds are superior to cotton seed meal (201.0 g/kg) and coconut meal (177.0 g/kg), but are inferior to linseed meal (342.0 g/kg), groundnut cake (453.0 g/kg) and soybean meal (413.0 g/kg) (Barrett and Larkin 1977).

From the foregoing discussion, it may be concluded that except for *Annona muricata*, all seed samples analysed are potentially good sources of dietary energy and protein supplements for ruminants. However, there is the need to further investigate the inorganic matter for their mineral element constituents in order to ascertain adequacy or otherwise in meeting the animal requirement.

TABLE 3
Estimated digestible crude protein and digestible energy values of seed samples

Seed samples	Digestible energy, DE (MJ/kg)	Digestible energy, DE (% of Total energy)	Digestible crude protein (g/kg)
Jatropha curcas	20.1[a*]	87.9[a]	261.1[a]
Trichosanthes cucumerina	19.5[b]	76.0[b]	269.4[a]
Annona muricata	9.0[c]	46.9[c]	66.5[b]
Citrullus vulgaris	21.9[a]	85.5[a]	253.0[a]
± SEM**	2.9	9.42	48.8

*Mean values followed by different superscripts in a column are significantly different ($P<0.05$).
**Standard error of the mean.

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(Received: 21 July 2000)
(Accepted: 10 May 2002)