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# The use of sorrel (*Hibiscuss sabdariffa*) seed as a feed ingredient for poultry: A review

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## Abstract

Sorrel (*Hibiscuss sabdariffa*) is a tropical annual herb of the family Malvaceace believed to have originated from tropical Africa but now cultivated in many parts of the world. Sorrel seeds have little food or industrial uses in Nigeria at the moment. Sorrel seeds are moderate to good sources of protein with an amino acid composition similar to soybean, but contain several toxic factors and have a highly acidic taste. Several processing methods have been employed to reduce these factors and increase the utilization of the seed by poultry but yet with some limitations. The composition of sorrel seed (nutrients and antinutritional factors), common processing methods, and the results of some poultry feeding trials were reviewed.

**Key words:** *Hibiscuss sabdariffa*, Toxicity, Poultry Feeding

## Introduction

Sorrel (*Hibiscuss sabdariffa*) is a tropical annual herb of the family Malvaceace believed to have originated from tropical Africa (Mc Clean, 1973) but now cultivated in many countries of the world (Tindal, 1986; Kalyane, 1986). In Nigeria, sorrel is grown as a border crop with the calyces used for the production of a popular non alcoholic beverage ("Zobo") as well as sauce, jams, jelly and colouring materials for food, wines and drugs (Kalyane, 1986; Rao, 1996; Abu-Tarboush et al., 1997; Tsai et al., 2002). The leaves form a popular vegetable in most regions of the world (Tindal, 1986; Ojokoh, 2006). In recent years, because of the increased demand for the calyx in Nigeria for the commercial production of "Zobo" (local beverage), the cultivation practice of sorrel is gradually changing from the traditional border crop to a more integrated type with other crops. However, despite this increase in the production, sorrel seeds have little food or industrial uses in Nigeria at the moment (Aruna et al., 2007; Kwari et al., 2011). Sorrel seeds are reported to be good sources of protein (Rao, 1996; Tomas-Jinez et al., 1998; AFRIS, 2004; Kwari et al., 2011) but contain several toxic factors (Evans and Bandemer, 1967; Morton, 1987; Aletor, 1993; Ojokoh et al., 2002; Mukhtar, 2007; Kwari et al., 2011) which are usually absorbed intact by monogastric animals causing various harmful effects. It is therefore a challenge to the poultry nutritionist to devise means of reducing these factors in sorrel seed with the view to maximizing its utilization by poultry. This paper reviews the nutritional composition and toxic factor content of sorrel seed, some common techniques employed to detoxify these factors as well as results of feeding trials in poultry.

### Types of sorrel seed

Based on the colour of the calyx there are three (3) commonly grown cultivars of *Hibiscuss sabdariffa*. These are the dark red, light red and white calyx bearing cultivars. Although, the colour has been reported to affect the chemical composition of the calyx (Adanlawo and Ajibade, 2006), chemical analyses of the seed have rarely distinguished between these cultivars.

### Nutrient composition

Sorrel seed is a moderate to excellent source of protein with the crude protein ranging from 21-39%. Like protein, the fat (6-19%) and crude fibre (12-22%) also vary within wide ranges. An exceptional quality of sorrel seed is the amino acid profile of its protein. Literature shows that sorrel seed is comparable to soybeans with regard to the essential amino acid profile. The fat of the seed is a good source of essential fatty acids (arachidonic, linoleic and linolenic acids) which are required to prevent fatty acid deficiency diseases such as skin lesions and low growth rate (Kinsella, 1987). The protein, fat and crude fibre contents and the essential amino acid composition of sorrel seed as reported by different authors are shown in Table 1. Several factors may be responsible for the

**Table 1: Chemical and essential amino acids composition of sorrel seed and soybean.**

| Constituents (%) | Sorrel seed | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | [8]soyabean |
| Crude protein | 24.00 | 26.48 | 39.40 | 21.35 | 22.20 | 32.28 | 38.57 | 40.00 |
| Ether extract | 22.30 | 20.13 | 6.10 | 17.43 | 6.00 | 19.90 | 13.50 | 19.00 |
| Crude fibre | 15.30 | | 17.70 | 11.98 | 15.00 | 22.30 | 16.50 | 7.50 |
| Arginine | 3.60 | 10.65 | 9.60 | | | 11.69 | 5.18 | 3.69 |
| Histidine | 1.50 | 1.91 | 2.70 | | | 2.22 | 1.99 | 1.80 |
| Isoleucine | 3.00 | 2.96 | 4.70 | | | 4.24 | 3.30 | 2.20 |
| Leucine | 5.00 | 5.58 | 8.00 | | | 7.99 | 4.99 | 3.93 |
| Lysine | 3.90 | 5.12 | 5.90 | | | 4.84 | 2.58 | 3.54 |
| Methionine | 1.00 | 1.44 | 1.60 | | | 1.11 | 1.33 | 0.00 |
| Phenylalanine | 3.20 | 5.96 | 5.10 | | | 5.35 | 4.17 | 2.60 |
| Threonine | 3.00 | 2.67 | 3.40 | | | 3.34 | 2.83 | 1.93 |
| Tryptophan | | 0.76 | 1.30 | | | | 0.73 | 0.67 |
| Valine | 3.80 | 4.57 | 5.40 | | | 5.83 | 3.19 | 2.30 |

1: Morton (1987) 2: Abu-Tarboush et al. (1997) 3: Fagbenro et al. (2004) 4: Mukhtar (2007) 5: Aruna et al. (2007) 6: Abu El Gasim et al. (2008) 7: Kwari et al. (2011). 8: Olomu (1995)

variations in chemical composition but varietal differences as observed in the composition of the calyx (Ojokoh, 2006) as well as differences in the analytical procedures could be of significance.

**Antinutritional factors**

Despite the rich nutritional composition of sorrel seed, there are reports of the presence of a number of antinutritional (toxic) factors. However, there has been conflicting results as per the presence/concentration of these factors probably due to varietal differences. The most commonly reported toxic factors in sorrel seed are total phenols and tannins (Abu El Gasim et al., 2008; Kwari et al., 2011) and phytic acid (Evans and Bandemer, 1967; Kwari et al., 2011).

Glucosides such as delphinidin-3-monoglucosides and delphinidin (Morton, 1987; Ojokoh et al., 2002) and cyanogenic glucosides (Aletor, 1993) have also been reported in sorrel seed. Recently, Mukhtar (2007) reported that sorrel seed contains traces of gossypol, a phenolic compound which causes undesirable physiological effects in poultry. Liener (1975), Abu-Tarboush and Ahmed (1996), Abu-Tarboush et al. (1997) and Hansawasdi and Kawabata (2000) reported low levels of tannin, amylase inhibitors, protease inhibitors, phytic acid and gossypol in sorrel seed. The levels of selected antinutrients in sorrel seed are shown in Table 2.

**Effect of processing on the nutritional quality of sorrel seed**

Different processing methods have been reported to reduce the toxic factors in feeds. Jirapa et al. (2001) and Yagoub and Abdalla (2007) observed that processing methods such as soaking, cooking or sprouting significantly improve the nutritional and functional properties of plant seeds.

**Table 2: Some antinutritional factors in sorrel seed**

| Antinutritional factor | Sources | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Total phenols (%) | ND | 8.7 | 7.19 |
| Tannin (%) | 5.30 | ND | 3.29 |
| Phytic acid (%) | 2.14 | 8.88 | ND |
| Cyanide (mg/kg) | 3.50 | ND | ND |

1: Ojokoh (2006); 2: Yagoub and Abdalla (2007); 3: Kwari et al. (2010); ND: not determined

There are few reports on the processing of sorrel seed with the view to reducing the toxic factors and improve its feeding value. Abu El Gasim et al. (2008) reported a significant reduction of phenolic compounds in the soaked, cooked or sprouted sorrel seed compared to the raw, but the phytic acid content was not affected by processing. In a similar study, Kwari et al. (2011) observed significant reduction of total phenolics and condensed tannin of the seed by soaking, cooking, sprouting or fermentation. These processing methods, however, had both beneficial and adverse changes in the profile of certain nutrients.

In their study, Abu El Gasim et al. (2008) observed that the reduction of phenolics by soaking, cooking or sprouting were accompanied by significant increase in protein, fat and crude fibre contents while the ash and soluble carbohydrate contents were reduced. The authors also reported an increase in the sulphur amino acids (methionine, cystine and threonine) and decrease in lysine contents of the soaked compared to the raw seed. In contrast, Kwari et al. (2011) observed that soaking reduced the methionine but had no adverse effect on the lysine contents of sorrel seed. Abu El Gasim et al. (2008) soaked the seed in sodium azide solution for 12 hours while Kwari et al. (2011) soaked in tap water for 24 hours. These differences in medium and duration of soaking may be partly responsible the

**Table 3: Effect of processing on the nutrient composition and antinutrient content of sorrel seed**

| Constituents | Processing methods of sorrel seed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Raw | Soaked in sodium azide (12h) | Soaked in $H_2O$ (24h) | Sprouted (24 h) | Sprouted (48h) | Cooked (20min) | Cooked (30min) | fermented | Sources |
| Crude protein (%) | 32.28$^{c}$ | 32.49$^{a}$ | | 32.43$^{ab}$ | 32.34$^{bc}$ | 32.33$^{c}$ | | | 1 |
| | 38.57 | | 38.20 | 37.04 | | | 37.80 | 38.59 | 2 |
| Oil (%) | 19.90$^{d}$ | 20.63$^{b}$ | | 21.09$^{a}$ | 20.80$^{b}$ | 20.37$^{c}$ | | | 1 |
| | 20.50 | | 19.06 | 18.50 | | | 18.82 | 19.30 | 2 |
| Crude fibre (%) | 22.30$^{c}$ | 22.62$^{c}$ | | 23.31$^{b}$ | 24.38$^{a}$ | 24.47$^{a}$ | | | 1 |
| | 16.50 | | 15.80 | 15.30 | | | 15.14 | 15.50 | 2 |
| Soluble carbohydrates (%) | 10.17$^{a}$ | 9.86$^{b}$ | | 9.78$^{b}$ | 9.83$^{b}$ | 9.70$^{b}$ | | | 1 |
| | 11.63 | | 15.54 | 17.43 | | | 16.84 | 16.11 | 2 |
| Total polyphenols (mg/g) | 8.78$^{a}$ | 8.80$^{a}$ | | 8.84$^{a}$ | 8.81$^{a}$ | 8.54$^{b}$ | | | 1 |
| | 7.19 | | 6.66 | 5.85 | | | 4.93 | 5.39 | 2 |
| Condensed tannin (mg/g) | 3.29 | | 2.59 | 3.47 | | | 2.17 | 2.59 | 2 |
| Phytic acid (mg/g) | 8.88 | 8.89 | | 8.86 | 8.88 | 8.85 | | | 1 |

1: Abu El Gasim et al. (2008); 2: Kwari et al. (2011)

**Table 4: Effect of processing on the essential amino acids content of sorrel seed**

| Essential amino acid (%) | Processing methods of sorrel seed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Raw | Soaked in sodium azide (12h) | Soaked in $H_2O$ 24h) | Sprouted (24h) | Sprouted (48h) | Cooked (20min) | Cooked (30min) | fermented | Sources |
| Arginine | 11.69 | 11.57 | | 11.87 | 11.43 | 11.16 | | | 1 |
| | 5.18 | | 5.50 | 4.80 | | | 5.42 | 5.70 | 2 |
| Histidine | 2.22 | 2.10 | | 3.22 | 3.66 | 3.58 | | | 1 |
| Isoleucine | 4.24 | 4.18 | | 4.05 | 4.20 | 4.09 | | | 1 |
| Leucine | 7.99 | 7.92 | | 7.73 | 7.80 | 7.68 | | | 1 |
| Lysine | 4.84 | 3.11 | | 3.52 | 3.68 | 4.81 | | | 1 |
| | 2.58 | | 2.54 | 2.06 | | | 2.73 | 2.64 | 2 |
| Methionine | 1.11 | 1.35 | | 0.68 | 0.96 | 0.91 | | | 1 |
| | 1.33 | | 1.19 | 1.04 | | | 1.18 | 1.20 | 2 |
| Phenylalanine | 5.35 | 5.43 | | 5.15 | 5.19 | 5.15 | | | 1 |
| Threonine | 3.34 | 3.43 | | 3.36 | 3.41 | 3.40 | | | 1 |
| Tryptophan | 0.73 | | 0.66 | 0.49 | | | 0.63 | 0.55 | 2 |
| Valine | 5.83 | 5.61 | | 5.47 | 3.86 | 5.63 | | | 1 |

1: Abu El Gasim et al. (2008); 2: Kwari et al. (2011); Means followed by the same letter are insignificantly different according to DMRT ($P \leq 0.05$)

for the differences in the results. The duration of cooking (20 and 30 minutes respectively by these authors) had no adverse effect on the lysine content of the seed. Prolonged application of heat however, may induce the loss of some lysine due to the formation of Maillard products as observed by Parsons et al. (1992). This means that cooking time must be long enough to achieve maximum reduction of the antinutrients and short enough to preserve the amino acid (especially lysine) profile of the seed. Another challenge for nutritionists is therefore that of establishing the optimum cooking conditions for sorrel seed. Furthermore, any processing method that leads to appreciable loss of dry matter should be approached with caution. Tables 3 and 4 summarize the effects of processing on some antinutritionals factors and the nutrient composition of sorrel seed.

**Poultry feeding trials**

An important role on feeding of sorrel seed to poultry were cited in different studies. Mukhtar (2007) fed graded levels (0.0, 7.5, 15.0, and 22.5%) of raw sorrel seed meal and observed decreased feed intake, weight gain and feed conversion ratio in broiler chickens when the level of inclusion increased above 7.5%. In another experiment, Kwari et al. (2011)

replaced the soyabean meal with raw sorrel seed meal at 0.0, 25.0, 50.0, 75.0, and 100.0% in broiler diets and reported a decreased performance (feed intake, weight gain, and feed conversion ratio) only above 50.0% replacement (12.0% of dietary sorrel seed). Similarly, feeding this level of sorrel seed (raw or processed) had no significant effects on feed intake, feed conversion ratio, egg production, and egg quality of laying hens (Kwari et al., 2011). Kwari et al. (2010) also reported no adverse effects of feeding raw sorrel seed on feed intake, growth, feed conversion and carcass yields of cockerels.

Gobley (1956) reported a high acid taste and sickly odour of sorrel seed. This taste/odour rather than toxicity may be the reason for the poor performance as the weight of organs such as the liver, heart (Mukhtar, 2007; Kwari et al., 2011) and pancreas (Mukhtar, 2007) were not affected by the level of inclusion of the test material in both egg and meat type chickens. Similarly, the pattern of the blood parameters (haematology and chemistry) was not traceable to dietary treatment (Kwari et al., 2011). The haematology, serum chemistry and organs (gizzard, hearth and liver) weight of cockerels were also not affected by feeding raw compared to processed sorrel seeds (Kwari et al., 2010). Damang and Guluwa (2009) included up to 30% raw sorrel seed meal in the diet of broiler chickens and reported no adverse effects on the performance of the birds at starter or finisher phase.

Kwari et al. (2011) however, reported improvements in the growth performance of broiler chickens when sorrel seed was processed by soaking, cooking, sprouting or fermentation. These processes might have brought about an improvement in the taste of the seed probably through leaching in processing water and enzyme activity during sprouting and fermentation as earlier observed by Obizoba and Ath (1992), Saikia et al. (1999) and Yagoub and Abdalla (2007).

## Conclusion

Going by its nutrient composition sorrel seed has potentials for use as major source of protein in poultry diets. However, the presence of several antinutrients and the highly acidic taste of the seed seem to be limiting factors to its maximum utilization for poultry feeding. Nutritionists are therefore saddled with the challenge of looking into cheaper methods of processing that will reduce these factors without significant loss of nutrients and enhance feed intake and nutrient utilization.

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