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NUTRITIVE AND ANTI-NUTRITIVE COMPOUNDS OF OIL SEEDS RENEWABLES AND BY-PRODUCTS IN THE LIVESTOCK INDUSTRY

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ABSTRACT: *Nigeria is one of the major oilseeds producers in Africa due to favorable climatic and edaphic factors. They strive well under rain-fed conditions; under low rainfall the crops experience moisture stress causing low yield. Oil seeds have recently attracted more interest due to their nutritional composition and the demand keeps rising due to the increase in population growth. Oilseed products such as soybeans, cottonseed, rapeseed, sunflower, and camelina meal or cake are sources of amino acids, and digestible rumen protein and minerals that influence animal growth and development. Due to the considerable amount of polyunsaturated fatty acids, it causes toxins accumulation and inflammation. The presence of antinutrients such as glucosinolates, trypsin inhibitors, gossypol, and lectins in these oilseeds inhibits their protein degradability, mineral bioavailability, flavor, and taste. Animals are affected by the toxicity of antinutrients leading to diseases and death. Glucosinolates, trypsin inhibitors, are known to reduce feed intake and cause iodine deficiency causing goiter and enlargement of the liver, kidney, and thyroid of animals which consequently affects the body. This paper summarizes the nutritive and anti-nutritive values of different oil seeds, the effect of different livestock animals, and the methods of reducing or eliminating the attributive compounds.*

KEYWORDS: Oilseed, Nutritive, anti-nutritive, glucosinolates, livestock.

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INTRODUCTION

The World oil crops and products market shows that the world production of oil crops is 617.8 million tonnes (FAO, 2022). The geometric increase in the world population consequently causes an increase in demand for feedstuffs which is causing competition between humans and animals; this poses different challenges, especially from the perspective of animal nutrition. Animal nutrition is one of the most important aspects of modern animal agriculture; thus, the knowledge of the nutritional values of feedstuffs and food processing techniques of these feedstuffs plays crucial roles in harnessing their use in animal diets. Oilseed meal is the most well-known source of protein in animal feed, used in the least-cost feed formulation for livestock due to its wide acceptability and nutritional composition. The wide gap between suppliers and consumption for these major feed ingredients is expected to increase drastically over the coming decades due to the increase in population growth of the world. Oilseed crops are grown throughout the world and the considerably high protein content (18-49%) makes them suitable sources of food grade (Sarv, 2017). Oilseed crops include soybeans, cottonseed, rapeseed, camelina sativa, and peanuts. The importance of dietary protein is to provide amino acids that are necessary for the growth and maintenance of body tissue. Due to the increased demand for protein, oilseeds serve as an alternative source of protein that can be renewed and used by both animals and humans. Despite its usefulness, the problem with oilseed crops is the presence of different flavors and anti-nutritional components.

MATERIALS AND METHODS

A systematic search of published articles in Google Scholar and Science Direct databases was conducted using the following sentence feed management methods and poultry profitability. The results of the search were analyzed and presented in text and tables.

RESULTS AND DISCUSSION

Cotton Seed

Cottonseed is a rich source of crude protein and amino acids, although the nutrient concentration varies in different cottonseed meal samples and is often high. The variation in the chemical composition of cottonseed is dependent on various factors such as varieties of species, location differences, maturity stage of the cotton, the proportion of husks, and processing methods during oil extraction. Cottonseed meal is a by-product of the cottonseed obtained from the oil extraction process and is widely used as a feed ingredient for farm animals due to its high amino acids profileand relatively cheap price and availability (Kumar *et al.,* 2014). The oil content of the cottonseed serves as energy content. Crude cottonseed oilcake is an inexpensive and readily available by-product of cottonseed obtained after oil extraction. Table 2 shows the proximate analysis ofcottonseed cake.

The oilseed is subjected to various processing methods as shown in Figure 1, like oil extraction, mechanical extraction, ghani extraction, and mechanical pressing continuous screw press (expeller). Therefore, it is important to understand the nutrient composition of

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cottonseed meals and their potential impact on animal health and productivity. Previous research has shown that cottonseed meals can be a valuable source of protein, energy, and minerals for ruminants (Kumar*et al.*, 2014). One of the antinutritional compounds Gossypol, a secondary metabolite stored in the pigment glands of cottonseed, is widely known for numerous antinutritional effects that limit its use as an alternative protein source (Yue & Zhou, 2008). Higher inclusion of the CSM decreased the body weight gain and Feed Conversion Ratio.

Camelina Sativa

Camelina Sativa belongs to the *Brassica* family and is related to rapeseed namely: (*B. napus*), mustard (*B. juncea)*, and canola (*B. napus*). It is also called false flax and German sesame. The chemical composition of the camelina meal and flax meal is shown in Table 2. It can strive well under a wide range of soil, preferably loamy soil due to its high holding capacity of moisture and it requires little or no fertilizer or pesticide to realize optimum yields. Camelina meal is the by-product gotten after the cold pressing of its seeds and the extraction of the oil. It serves as an alternative feedstuff in poultry diets due to its high residual oil (from 50 to 130 g/kg) and its high fatty acid concentration, which ranges from 25 to 30% of total fatty acids (Cherian *et al.*, 2009). Another major by-product of camelina is camelina oil and camelina cake, which has the potential to be a feedstuff for livestock animals' diets. Camelina sativa is a potential dietary source of amino acids for livestock. The remaining oil in the cake increases its calorie content compared to the solvent-washed meal.

Studies have shown that the water-soluble yellow mustard mucilage shows strong antioxidant properties, compared to pectin and xanthan gum (Wu *et al.,* 2016). The proportionally high content of mucilage, crude fiber, and lignin in Camelina sativa meal, when incorporated into food, can exert positive effects on the gastrointestinal tracts of farm animals.

Rapeseed

Rapeseed (Brassica napus L.) is a very nutrient-dense oilseed crop that is frequently utilized in the preparation of animal feed. It has been demonstrated to positively influence animal growth, development, and general health because it is abundant in protein, fiber, minerals, and oil (Arthur,J. R. et al., 2018).

Rapeseed meal is a strong source of protein and is a crucial component for animal growth. According to Knutsen et al. (2017), rapeseed meal has a crude protein concentration that ranges from 35% to 50%, and the protein quality is regarded as good. According to studies by Sarker, M.

A. R. *et al.* (2020), rapeseed meal has a dry matter crude protein content of about 40.1%. Moreover, rapeseed meal includes important amino acids for animal growth and development, including

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lysine, methionine, and cysteine (Gao, C. *et al.,* 2020). Rapeseed meal does, however, also contain anti-nutritional elements such as phytic acid and glucosinolates, which can impair animal performance and diminish protein digestion (Li, Y. *et al.,* 2017).

The crude fiber content of rapeseed meals ranges from 12% to 17% (Sarker, M. A. R. *et al.,* 2020).Fiber is crucial for preserving gut health and encouraging the development of good gut flora in animals. It contains minerals that are crucial for maintaining the health of animals, including phosphorus, potassium, calcium, magnesium, and sulfur (NRC, 2012).

A report by Oomah, B. D. (2019) shows that the oil content of rapeseed ranges from 40% to 50%, and rapeseed oil is composed of 60% to 70% unsaturated fatty acids, which can have health benefits for animals. Rapeseed oil can be used as a feed ingredient or as a source of energy in biofuels. Studies by Vassilev, N. B. (2015) suggest that rapeseed meal contains 0.67% P, 1.23% K, 0.17% Ca, 0.44% Mg, and 0.27% S on a dry matter basis. Rapeseed oil is another valuable component of rapeseed for animal feed.

ANTINUTRITIONAL COMPOUNDS

1. Glucosinolates

The glucosinolates, the natural components of pungent plants from the *Brassicaceae* family, belong to the class of organic compounds glucosides. The glucosinolate composition of any Brassica seed is a combination of different glucosinolates, with one type as the main form; the ingestion of high amounts of glucosinolates may be toxic to animal health and production. Upon ingestion, the intact glucosinolates and/or their breakdown products are either absorbed from the intestinal lumen and/or converted into other products (Rowan *et al.*, 1991). Glucosinolates cause enlargement of the liver, kidney, and thyroid (Mabon *et al.,* 2000).

2. Phytates

Phytates, also known as phytic acid, are another antinutrient of plant origin common in many vegetable products (Petroski & Minich, 2020). Camelina seeds store phosphorus as phytic acid intheir husks in the form of phytate salt or phytin. The presence of phytic acid decreases the bioavailability of micro and microminerals, solubility, functionality, and degradability of carbohydrates and proteins (Kadam *et al*., 1990). The digestive enzyme phytase transforms the stored phosphorus into phytic acid. Phytates affect the functions of digestive enzymes like amylase, trypsin, and pepsin (Kumar *et al*., 2010).

3. Goitrogen

Peanut seed inhibits iodine uptake by humans and animals. Such inhibition leads to an inadequate supply of iodine in the thyroid, consequently causing goiter. The goitrogenic compounds are present in peanuts, mustard leaves, soybeans, lentils, and millet. Soybeans and peanuts produce goitrogenic effects. For soybeans, the causal agent is a low molecular weight oligo-peptide consisting of 2 or 3 amino acids (Dolan et al., 2010). The goitrogenic principal in peanuts is the phenolic glucoside which resides in the skin, thereby impeding the supply of iodine into the thyroid.

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4. Oxalic and Phytic Acid

Oxalic acid is one of the many anti-nutritional contents that affect the nutrients in the gastrointestinal tract of farm animals. Oxalic acid chelates the necessary minerals such as calcium, phosphorus, and sodium; this results in diseases such as osteomalacia and rickets. Due to the complex stomach structure and presence of rumen bacteria, it helps break down oxalate into harmless acid and carbon dioxide (Allison et al., 1977). *Oxalobacter formigenes* and *Enterococcusfaecalis* are notable rumen bacteria capable of degrading oxalate (Campieri et al., 2001). Leguminous seeds and peanuts contain trypsin inhibitors and other protease inhibitors and can be destroyed by proper processing. The presence of aflatoxin is produced by the fungus *Aspergillus flavus* which infests peanuts before, during, and after harvest. Aflatoxin is responsible for causingcancer (Kumar *et al.,* 2017).

Approaches To Reduce Antinutrients

Several methods have been used to reduce or get rid of the deleterious effects of different antinutritional factors in animal feeds. The various strategies for ameliorating the harmful effects of anti-nutritional factors are available in animal nutrition. The methods improve the quality of ruminant feeds and the acceptability by animals which resultantly improves the quality of animal products and by-products. Common methods include milling, soaking, fermentation, sprouting, germination, gamma radiation, and genomic technology (Samtiya *et al.,* 2020). Milling is the mostancient method to separate the grain from the bran layer. In this method, grains are ground into powder/flour, and it has been reported to be useful in removing phytic acid, tannin, and lectins present in the bran of grains (Samtiya *et al*., 2020). However, the setback of this method is that several minerals are lost during milling (Gupta *et al.,* 2015). Soaking is a treatment method to remove water-soluble antinutrients in the feedstuffs. Soaking usually involves the use of distilled water, 1% NaHCO3, and mixed salt solutions. It has been reported that soaking using those combinations reduces phytates and phenols by 21% and 33% respectively (Devi *et al.*, 2018). Soaking reduces soluble sugars, tannins, and the total proteins in soybean flour. Soaking has been reported as one of the excellent ways of removing or deactivating enzyme inhibitors, though lectinis not affected by this method (Shi *et al.,* 2017). Table 3 summarizes the method of removing antinutrients.

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APPENDIX

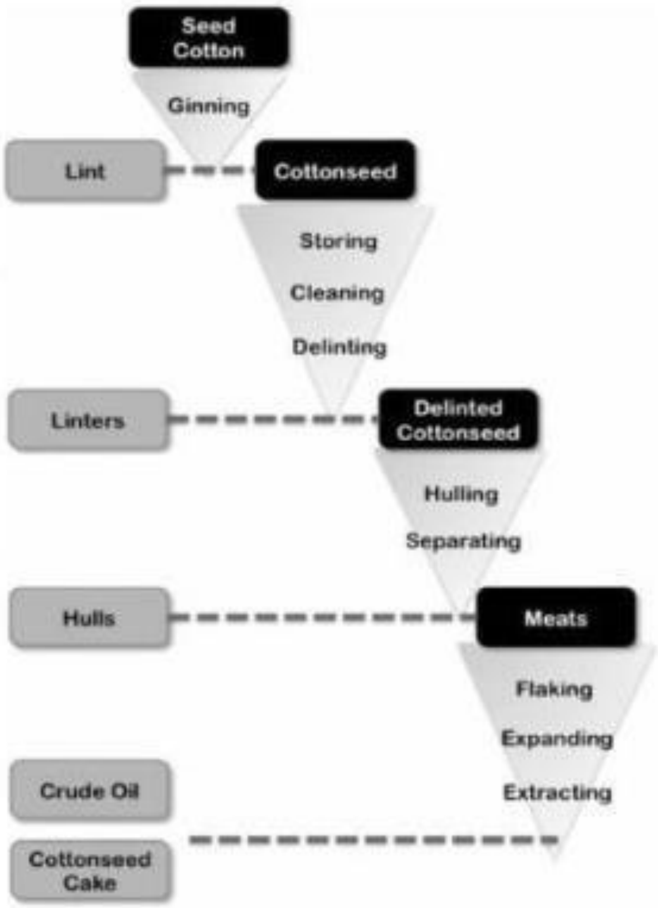

Figure 1: Steps in the processing of cottonseed meal (Blasi et al., 2002)

Table 1: Proximate analysis of cotton seed cake

S/N	Composition	Mean percentage %
1	Moisture	3.23+0.23
2	Ash	6.93+0.71
3	Lipid	3.22+0.77 4
4	Crude fibre	14.16+0.58
5	Crude protein	26.02+0.10
6	NFE	46.21+01.14

Source: JIbrin *et al.,* 2020

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Table 2: Chemical composition of camelina meal and flaxseed

Nutrient composition	Camelina meal	Flax meal
Gross energy (kcal/kg)	5,429	4,120
CP (%)	26.5	34.3
Crude fat (%)	27.5	2.45
NDF (%)	39.9	27.7
Threonine	1.08	1.12
Glumatic acid	4.26	6.55

Sources: (Abeer *et al.*, 2013)

Table 3: Different antinutrients and the method of removing antinutrients

Antinutrients	Methods of Removing Antinutrients	References
Goitrogens	Boiling, and steaming	(López-Moreno *et al.*, 2022)
Lectins	Boiling, soaking, autoclaving, fermentation, and germination	(Liu, 2004)
hytase	germination, fermentation, Soaking, boiling	(López-Moreno *et al.*, 2022)
Glucosinolates	Sprouting, cooking, and supplementing with iodine	(López-Moreno *et al.*, 2022)

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