Qualitative and quantitative assessment of antinutrient components of oyster mushroom (*Pleurotus ostreatus*) stalks and almond fruit (*Prunus dulcis*) hulls

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ABSTRACT

This study explored the potential of oyster mushroom stalks and almond fruit hulls as alternative animal feed resources, focusing on their antinutrient components as well as to identify appropriate extracting methods. This was achieved through qualitative and quantitative assessment of antinutrients such as flavonoids, tannins, saponins, oxalates and phytates. Data were statistically analyzed to validate the effectiveness of these methods and the suitability of the by-products as sustainable feed resources. The findings indicated that the studied wastes can promote environmentally friendly agricultural practices and cost-effective feed alternatives in livestock production. Almond hulls contained significant levels of saponins (4.89 g/100 g) and flavonoids (1.37 g/100 g), while mushroom stalks were notable for higher tannins (3.63 g/100 g) and alkaloids (0.97 g/100 g). Phytate and oxalate levels in both materials were within permissible limits for animal feed, indicating minimal toxicity risks. Qualitative analysis revealed that ethanol extraction was more effective for alkaloids, tannins and flavonoids in mushroom stalks, while aqueous extraction was more efficient for saponins. On the other hand, almond hulls exhibited higher tannins concentration in aqueous extracts, whereas ethanol extracts favoured saponins. The findings suggest that these by-products could be viable, sustainable alternatives in animal nutrition. The study recommends the possible use of oyster mushroom stalks and almond fruit hulls as feedstuff resources for an enhanced nutrient availability as well as using ethanol for extracting alkaloids and flavonoids and water for saponins to optimize nutrient benefits.

Key words: Agro-wastes, almond hulls, oyster mushroom stalks, antinutrient contents, feed resources

INTRODUCTION

The demand for sustainable and nutritionally rich animal feed resources is rising, particularly as conventional feed ingredients become costly and environmental concerns regarding resource -intensive feed crops intensify (Makkar *et al.,* 2022; Umoren *et al.*, 2024). This has led researchers to explore agricultural by-products as alternative feed sources due to their abundance, nutritional potential, and cost-effectiveness (Akande *et al.,* 2021). Among these by-products, oyster mushroom stalks (*Pleurotus* spp.) and almond fruit hulls (*Prunus dulcis*) have garnered interest due to their rich biochemical composition, although they also contain various antinutritional factors that could impact animal health and productivity (Al-Mashhadani *et al.,* 2023).

In recent years, the global push for sustainable agriculture has encouraged the exploration of alternative feed resources, especially those derived from agricultural and food processing by-products (FAO, 2023). This shift is motivated by the rising costs of traditional animal feed ingredients like soy and maize, as well as the environmental impact associated with their large-scale cultivation (Makkar *et al.,* 2022). One approach to address these challenges involves utilizing unconventional feed resources, including oyster mushroom stalks and almond fruit hulls, which are abundant, low-cost, and nutritionally promising. These by-products, however, contain varying levels of antinutritional factors that could impede their utility in animal nutrition if not adequately assessed and managed (Akande *et al.,* 2021).

Oyster mushrooms (*Pleurotus* spp.) are widely cultivated for food and medicinal purposes, leaving behind residual stalks as waste material. Research indicates that oyster mushroom stalks are rich in fiber, proteins, vitamins, and bioactive compounds that may promote livestock health and productivity (Cheung *et al.,* 2021). However, stalks also contain antinutritional factors such as oxalates, phytates, and certain non-starch polysaccharides, which can interfere with mineral absorption, protein digestibility, and energy availability in animals (Anwar *et al.,* 2023). Therefore, evaluating the qualitative and quantitative antinutrient profile of oyster mushroom stalks is essential for determining their potential as an animal feed component.

Almond fruit hulls, by-products of Almond (*Prunus dulcis*) processing, are another viable alternative feed ingredient. Almond hulls are typically discarded or used in limited applications despite their valuable bioactive profile, including tannins, phenolic acids, and fiber (Mandalari *et al.,* 2023). While these compounds provide antioxidative benefits, tannins in particular are known to form complexes with proteins and minerals, thus hindering digestibility and nutrient absorption (Siddhuraju, 2022). Understanding the antinutritional properties of almond hulls can facilitate their incorporation into animal feed without compromising nutritional quality.

Antinutritional factors (ANFs) in animal feed have received increased attention due to their complex effects on animal physiology and productivity. ANFs like tannins, oxalates, phytates, and saponins reduce feed palatability, bind to essential nutrients, and impair metabolic processes when present in high concentrations (Ramírez *et al.,* 2022). While some ANFs can be beneficial in small quantities by stimulating gut health or immune responses, excessive levels can lead to nutrient deficiencies, reduced growth rates, and gastrointestinal issues in animals (Siddhuraju, 2022). Thus, assessing these factors in unconventional feed resources is vital to ensure the health and productivity of livestock. Antinutrients, such as tannins, phytates, and oxalates, are compounds that interfere with the absorption of essential nutrients, thus affecting the bioavailability of proteins, minerals, and vitamins in animal diets (Siddhuraju, 2022). Quantitative and qualitative assessment of these components is crucial to understanding the feasibility of using oyster mushroom stalks and almond hulls as feed. These assessments allow for the determination of safe inclusion rates and for the implementation of processing techniques that may reduce antinutrient levels, thereby optimizing their nutritional value (Ramírez *et al.,* 2022).

The global animal feed industry faces significant challenges in meeting the nutritional demands of the rapidly growing livestock population (Makkar, 2018; Daszkiewicz, 2022). Conventional feed resources, such as grains and soybeans, are often expensive and unsustainable. In response, researchers have explored alternative feed resources, including agricultural by-products like oyster mushroom stalks and almond fruit hulls as promising feed resources (Prgomet *et al.*, 2017; Sırakaya, 2023; Silva *et al.*, 2024; Törős *et al.*, 2024; Yao *et al.*, 2024; Itubochi *et al.*, 2025).

Oyster mushrooms (*Pleurotus ostreatus*) are widely cultivated fungi known for their edible and medicinal qualities. After harvesting the mushroom caps, stalks remain as by-products that are often discarded or used as low-value animal feed (Prgomet et al., 2017). However, oyster mushroom stalks have gained attention due to their nutritional composition, bioactive compounds, and potential applications in various industries (Singh *et al.,* 2022). Oyster mushroom stalks are rich in proteins, carbohydrates, fibers, and essential minerals, making them a potential source of nutrients for both human and animal consumption (Giri *et al.,* 2021). Research shows that these stalks contain considerable amounts of polysaccharides, which contribute to their dietary fiber content and offer prebiotic effects. In addition, they contain bioactive compounds like polyphenols, flavonoids, and antioxidants, which have been associated with health benefits (Iqbal *et al.,* 2023).

Bioactive compounds present in oyster mushroom stalks, such as ergothioneine, polysaccharides, and glucans, are known for their anti-inflammatory, antioxidant, and anticancer properties (Zhou *et al.,* 2022). Studies suggest that these compounds could be extracted for use in pharmaceuticals and nutraceuticals. The bioactive potential of oyster mushroom stalks has prompted research into their application in creating value-added products such as dietary supplements and functional foods (Li *et al.,* 2023).

Oyster mushroom stalks contains crude protein (20-30%), comparable to soybean meal (40-50%) and corn (8-10%) (Singh *et al.,* 2018), crude fiber (20-30%) higher than corn (5-10%) and soybean meal (5-10%) (Kumar *et al.,* 2017a). Energy content (2.5-3.5 kcal/g); similar to corn (3.5-4.5 kcal/g) (Meng *et al.,* 2019). It contains vitamins and minerals rich in copper, selenium, and potassium (Wang and Chen*,* 2020). Oyster mushroom stalks have been evaluated as feed supplements for poultry as it facilitates improved growth rate, feed efficiency, and egg production (Akinfemi *et al.,* 2017). It is also a reliable source of feed for swine which aids enhanced growth rate and nutrient digestibility (Wang and Chen*,* 2020). Furthermore, in ruminants, it helps to increase dry matter intake and facilitates nutrient utilization (Kumar *et al.,* 2017a).

Almond fruit has the following nutritional composition; crude protein (10-15%), lower than soybean meal but higher than corn (Singh *et al.,* 2018). Crude fiber (30-40%), higher than corn and soybean meal (Kumar *et al.,* 2017a), energy content (2.5-3.5 kcal/g), similar to corn and oyster mushroom stalks (Meng *et al.,* 2019), vitamins and minerals rich in potassium, magnesium, and phosphorus (Wang and Chen., 2020).

Plant-based feed ingredients are increasingly used in animal nutrition due to their availability, sustainability, and cost -effectiveness. However, these ingredients contain antinutrient components that can negatively impact animal health, growth, and productivity. Phytates are phosphorus-rich compounds found in legumes, cereals, and oilseeds (Reddy *et al.,* 2017). They bind minerals, reducing their bioavailability and potentially leading to deficiencies (Selle, 2017).Tannins are polyphenolic compounds in plants, particularly in legumes and sorghum (Kumar *et al.,* 2017b). They can inhibit enzyme activity, reduce nutrient absorption, and damage gut health (Mueller-Harvey and McAllan, 2019). Lectins are proteins in legumes, cereals, and tubers that can cause intestinal damage, inflammation, and impaired nutrient absorption (Lajolo and Genovese, 2019). Saponins are glycosides found in legumes, cereals, and vegetables (Guclu-Ustundag and Mazza, 2018). They can reduce nutrient absorption, alter gut microbiota, and cause hemolysis (Francis *et al.,* 2017).

Oxalates are organic acids in plants, particularly in spinach, beet, and rhubarb (Noonan and Savage, 2018). They can bind minerals, reducing their bioavailability and potentially causing kidney damage (Heaney and Weaver,2018). Alkaloids are nitrogenous compounds in plants, particularly in solanaceous plants (Potterat *et al.,* 2017). They can be toxic, causing neurological disorders, reproductive issues, and impaired growth (Crawford and Stevens, 2018). Glucosinolates are sulfur-containing compounds in Brassica plants (Verkerk *et al.,* 2018). They can inhibit thyroid function, reduce nutrient absorption, and cause goiter (Tripatti *et al.,* 2017). Antinutrient components in plant-based feed ingredients pose significant challenges to animal health and productivity. Understanding the types, effects, and mitigation strategies of these antinutrients is crucial for optimizing animal nutrition.

Antinutrients have several deleterious effects on animal health as it has the potency to decrease nutrient absorption, leading to impaired growth (Selle, 2017). Additionally, it leads to nutrient deficiencies as antinutrients can bind minerals, reducing their bioavailability and potentially causing deficiencies (Heaney, 2018). Gastrointestinal issue is another negative effect as antinutrients can damage gut health, causing inflammation and impaired nutrient absorption (Mueller-Harvey and McAllan, 2019). It can also induce reproductive issues as antinutrients affect reproductive health, particularly in males (Crawford and Stevens, 2018).

Given the global emphasis on sustainable agriculture, finding effective ways to repurpose agricultural by-products like oyster mushroom stalks and almond hulls aligns with circular economy principles and may contribute to reducing the environmental footprint of animal agriculture. The potential cost savings and nutritional benefits these by-products offer make them promising alternatives to traditional feed components, provided that their antinutritional factors are adequately managed (Makkar *et al.,* 2022; FAO, 2023). By assessing the antinutrient profiles of these materials, this study contributes to the development of more sustainable feed practices, supporting both economic and environmental goals within the livestock sector (Al-Mashhadani *et al.,* 2023; Zhang *et al.,* 2024).

The objective of this study was to identify and quantify the antinutrient components present in the stalks of oyster mushrooms (*Pleurotus ostreatus*) and hulls of almond fruit (*Prunus dulcis*), including alkaloids, saponins, phytates, tannins, flavonoids, and oxalates. They are possible potential sources of animal feed which is crucial in determining the suitability of these materials as animal feed resources. Antinutrients are substances present in plants that can interfere with the absorption of nutrients in the body; reduce the availability of essential nutrients to animals, thus, can affect their growth and productivity. Oyster mushrooms are widely cultivated and consumed in many parts of the world. However, the stalks of the mushroom, which are often discarded, may contain antinutrient components that could possibly limit their use as animal feed.

MATERIALS AND METHODS

Location of study

This research was conducted within the University of Calabar environment, and in the Petroleum Trust Development Fund (PTDF) Laboratory of University of Calabar, Calabar, Cross River State, Nigeria. Calabar is located at latitude 4°.9517`N and longitude 8°.322`E with an elevation above sea level 99 m. The average daily temperature is 20°C (77°F) (Google earth, 2020).

Preparation of Oyster mushroom stalks and Almond fruit hulls

Six kilogrammes (6 kg) of oyster mushroom were purchased from local mushroom farmer (Banisua Farms) around Calabar metropolis, Cross River state, Nigeria. Stalk (waste) generated from each kilogram of mushroom was averagely 400 g. The stalks were blended using a blender (Savanna blender SB-2022, 1.5 L jar 220-240 V 50 Hz 350 W), stored in labeled and transparent airtight containers until needed for analysis.

Almond hull samples were collected from ripe almond fruits obtained from the abundant almond trees located within the University of Calabar, Calabar, and its environs. The harvesting process utilized conventional on-farm methods, including ground picking of fresh fruits. This approach ensured the collection of high-quality samples. Upon collection, each fruit was thoroughly cleaned and weighed before the outer tissues (hull) covering the hard nut were carefully removed.

Procedures for phytochemical analyses for Oyster mushroom stalk and Almond fruit hulls

The selected phytochemical compounds of mushroom stalk and almond hull were analyzed by the standard method of Trease and Evans (1989).

Alkaloids determination

Apparatus: Weighing balance (analytical grade), beaker, measuring cylinder, water bath, spatula, funnel, washed bottle, oven, and desiccator.
Reagents: Samples filter paper, acetic acid, and ethanol, dilutes ammonium hydroxide, concentrated ammonia and distilled water.

Methods: 5 g of sample was weighed into a Beaker, 100 cm^3 acetic acid in ethanol (1:1) was measured into the sample container and covered to stand for 4 hours. The extracted samples were filtered after four hours. It was then concentrated using water bath to a quantity of the original volume. Ammonia solution was added to the concentrated sample until the precipitation was completed. The precipitate was allowed to settle, then filtered and washed with dilute ammonium hydroxide. The residue left was taken as the crude alkaloid. It was then dried in an oven and weighed.

Flavonoid determination
Reagents: 80% methanol, filter paper
Apparatus: Weighing Balance (analytical grade), Beaker, Measuring cylinder, Water bath, Spatula, Funnel washed bottle, Oven, Desiccator

Methods: 5 g of the sample was weighed into a beaker and extracted with 50cm^3 of 80% methanol at room temperature for 1 hour. The solution was filtered through filtrate paper. The filter was evaporated to dryness over water bath and oven, the weight of the dried extract was weighed and the result recorded.

Saponins determination
Apparatus: Weighing Balance (analytical grade), Beaker, Measuring cylinder, Water bath, Spatula, Funnel washed bottle, Oven, Desiccator, separatory funnel and stirrer.
Reagents: Sample, 20% Ethanol, Diethyl ether, n- butanol, 5% sodium chloride and distilled water.

Methods: 5 g of sample was dispersed in 50 cm^3, 20% ethanol in a beaker. The suspension was heated over a hot water bath for 4 hours with a continuous steering at about 60^{o}C. The mixture was filtered after 4 hours and the residue was re-extracted with another 25 cm^3 of 20% ethanol. The combine extract was concentrated to reduce to 40 cm^3 over water bath at 90^o C. The sample was transferred into a separatory funnel and 20 cm^3 of diethyl ether was added and shaken thoroughly. An aqueous layer of the extract was recovered, while the ether layer was discarded. The purification process was repeated and 60 cm^3 of n-butanol was added and the extract was washed twice with 10 cm^3 of 5% aqueous sodium chloride. The remaining extract was evaporated in a water bath and dried in an oven to a constant weight. The saponin content was then calculated in percentage using the method reported by Obadoni and Ochuko (2002) and Ejikeme *et al.* (2014).

Tanin determination
Apparatus: UV-spectrophotometer, measuring cylinder, test-tube with rack and washed bottle, plastic bottle shaker.
Reagents: Sample, distilled water, 0.1 N hydrochloric acid and potassium ferrocyanide.

Method: 0.5 g of the sample was weighed into plastic bottle and 50 cm^3 of water was added shaken for 1hour in a shaker. It was then filtered and 5 cm^3 of the extract was measured to a test tube and mixed with 3 cm^3 of 0.1 N HCL and 3 drops of ferrocyanide. It was allowed to stand for 10 minutes, then measured in the UV-spectrophotometer at 605 nm. Blank too was determined.

Phytic acid determination
Materials: Weighing balance, measuring cylinder, beakers, UV-Vis Spectrophotometer, washed bottle, funnel, heater, digestion set, filter paper, distilled water , 2 g Sample, 0.5 N Sodium Chloride, Ferric Chloride solution, Sodium hydroxide, Concentrated Sulphuric acid,

and 65% perchloric acid.

Method: 2 g of sample was weighed into 25 cm^3 portion of 0.5 N Hcl and was shaken for 30 minutes; 2 cm^3 of Ferric chloride solution was added to the extract. Ferric phytates precipitate formed and was converted to sodium phytate by the addition of 3cm^3 sodium hydroxide solutions. The precipitate was digested with acid mixture of equal portions of concentrated Sulphuric acid and Perchloric acid in a digesting set. The liberated phosphorus was quantified colourimetrically at 620 nm after colour development with molybaite reagent.

RESULTS AND DISCUSSION

Comparable qualitative analysis of anti-nutritional composition in oyster mushroom stalk from ethanol and aqueous extraction methods

Results of qualitative analysis of oyster mushroom stalks are presented in Table 1. From the table, alkaloids is present in ethanol extract (+ve) but absent in aqueous extract (-ve). Alkaloids toxicity concerns, as they can cause adverse health effects (Kumar *et al.*, 2017b). Saponins concentration is higher in aqueous extract (+++) compared to ethanol extract (+) and may inhibit nutrient absorption and cause gastrointestinal issues (Singh *et al.*, 2018). Phytate is present in both extracts, with moderate concentration in aqueous extract (++) and can inhibit mineral (zinc, iron, calcium) absorption (Mandalari *et al.*, 2023). Tannins was detected in ethanol extract (+) but absent in aqueous extract (-), agreed with earlier report of (López-Fandiño, 2012). Tannins interfere with protein digestion and reduce nutrient absorption (López-Fandiño, 2012). Flavonoids was absent in aqueous extract (-) but present in ethanol extract (+), and is in agreement with the report of Chen *et al.* (2012). Flavonoids may bind minerals, reducing bioavailability (Chen *et al.* (2012). Oxalate is present in both extracts (+), and agreed with the report of Guillamón *et al.* (2010). Oxalate interferes with mineral (calcium) absorption (Guillamón *et al.*, 2010). Ethanol extract was more effective for alkaloids, tannins, and flavonoids extraction, while aqueous extract was effective for saponins extraction.

Comparable qualitative analysis of anti-nutritional composition in almond hull from ethanol and aqueous extraction methods

Qualitative analysis of anti-nutrient composition of almond hull (Table 2) showed that alkaloids was detected in both extract methods at low concentrations (+), Saponins was present in high concentration in ethanol extract (+++) but low in aqueous extracts. Phytate was moderate in concentrationin ethanol extracts (++), and low for aqueous extract (+), the reverse trend was observed for tanins in almond hulls. Flavonoids and oxalate were present in both extracts methods at low levels (+). Ethanol extract was more effective for saponins extraction, while aqueous extract was effective for tannins extraction.

Anti-nutrients composition of fresh almond hulls and fresh oyster mushroom stalks

Results of the quantitative anti-nutrient composition of almond hull and fresh oyster mushroom stalk are presented in Table 3. The results showed that almond hull was found to contain 0.59 g/100 g of alkaloids, 4.89 g/100 g saponins and 0.80

g/100 g phytase. The value of 0.67 g/100 g, 1.37 g/100 g and 0.76 g/100 g were respectively recorded for tannis, flavonoids and oxalate. The phytate value of 0.80 g/100 g recorded in this study is within the range of 0.45 – 1.17 g/100 g reported by Kumar *et al.* (2017b). The 0.67 g/100 g and 4.89 g/100 g recorded for tannins and saponins, respectively, is higher than the range of 0.12 – 0.25 g/100 g and 0.05 – 0.15 g/100 g reported by Mandalari *et al.* (2023), and Singh and Mishra (2023), respectively for tannins and saponins. Oxalic values of 0.03 – 0.06 g/100 g reported by Kumar *et al.* (2017b) is lower than the 0.76 g/100 g obtained in this study. Phytase value (0.80 g/100 g: 0.8% equivalent) obtained in this study is lower than the value 1.5%, less than 2.0% and less than 2.5%, respectively recommended for poultry, swine and ruminants animals by NRC (1994, 1998 and 2011). Oxalates of 0.76 g/100 g obtained in this study is also lower than the recommended values of less than 1%, less than 1.2% and less than 1.5% reported by NRC (1994, 1998 and 2011) poultry, swine and ruminants in nutrient requirements.

Mushroom contains 0.97 g/100 g alkanoids, 4.89 g/100 g saponins and 0.47 g/100 g phytate. Tannin value of 3.63 g/100 g was recorded for mushroom. Flavonoids and oxalate values of 0.72 g/100 g and 0.91 g/100 g were recorded for mushroom. These values were lower than the 42.41 mg/100 g, 78.93 mg/100 g and 198.04 mg/100 g reported by Effiong *et al.* (2024) in a study to assess nutrient and anti-nutrient composition of *Pleurotus ostreatus*. Phytase obtained in this study is lower than 1.5%, less than 2.0% and 2.5% respectively, recommended for poultry, swine and ruminant animals by NRC (1994, 1998 and 2011). Oxalates value of 0.91 mg/100 g obtained in this study is also lower than the recommended values of less than 1%, less than 1.2% and less than 1.5% reported by NRC (1994, 1998 and 2011) for poultry, swine and ruminants in nutrient requirements.

Anti-nutrients are chemical compounds synthesized in natural foods during metabolism, and their presence (depending on concentration) could inhibit the maximum utilization of nutrients especially proteins, vitamins and minerals present in food (Fekadu *et al.*, 2013; Gemede and Ratta, 2014; Gemede *et al.*, 2016). Phytate and oxalate are anti-nutrients that reduce the bioavailability of minerals such as calcium, forming insoluble salts of these minerals.

Many authors reported soluble and insoluble oxalate as separately measurable components of the oxalate content of foods (Hanow and Hesse, 2002; Savage *et al.*, 2000). In food, oxalic acid is typically found as either sodium or potassium oxalate, which are water soluble, or calcium oxalate, which is insoluble. Magnesium oxalate is also poorly soluble in water, although the contribution of this salt to the insoluble fraction of oxalate in food is unclear (Nath *et al.*, 2022). Some of these anti-nutrients (phytate, oxalate and tannins) can be reduced by proper processing of food (Akinyeye and Ogundipe, 2011). The levels of anti-nutrients in the studied oyster mushroom stalks were below the safe and permissible toxic levels (phytate: 2-3%; Oxalates: 50-100 mg/day; tanins: 500 mg/day) (Ekpa and Sani, 2018; Birgitta and Gullick, 2000, TNS, 2025).

CONCLUSION

In conclusion, this study successfully

identified and quantified various antinutrient components in oyster mushroom stalks and almond fruit hulls, highlighting the presence of compounds such as alkaloids, saponins, phytates, tannins, flavonoids, and oxalates. Despite their potential to inhibit nutrient absorption, the antinutrient levels in oyster mushroom stalks are within safe limits and can be further reduced through food processing. The study also revealed that different extraction methods yield varied efficacy in isolating these compounds, with ethanol extracts being more effective for certain antinutrients like alkaloids and flavonoids, while aqueous extracts effected better yield for others like saponins. These findings offer insights into the safe utilization and possible potential health effects of these plant materials as feed resources for farm animals. Thus, these support their continued use with appropriate processing methods, to minimize antinutritional impacts.

RECOMMENDATION

Based on research outcome, it can be recommended to process oyster mushroom stalks and almond fruit hulls using methods that reduce antinutrient levels. Additionally, selecting the appropriate extraction methods, like using ethanol for alkaloids and flavonoids or water for saponins, can optimize the removal or reduction of specific antinutrients. Further research is advised to explore these processing techniques in detail, especially to maximize nutrient availability and enhance the health benefits of these plant materials while minimizing any antinutritional effects.

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Table 1: Qualitative analysis of anti-nutritional composition in Mushroom stalk using different methods

Methods	Alkaloids	Saponins	Phytate	Tannins	Flavonoids	Oxalate
Ethanol extract	+	+	+	+	+	+
Aqueous extract	-	+++	++	-	-	+

- = absent (-ve); + = Present (+ve)
+ =Low concentration; ++ = Moderate concentration; +++= High concentration

Table 2: Qualitative analysis of anti-nutritional composition in Almond hull using different methods

Methods	Alkaloids	Saponins	Phytate	Tannins	Flavonoids	Oxalate
Ethanol extract	+	+++	++	+	+	+
Aqueous extract	+	+	+	++	+	+

+ = Present (+ve)
+ =Low concentration; ++ = Moderate concentration; +++= High concentration

Table 3: Anti-nutrients composition of fresh almond hull and fresh oyster mushroom stalk

Parameters	Almond hull (g/100g)	Mushroom stalk (g/100g)
Alkaloids	0.59 + 0.05	0.97 + 0.06
Saponins	4.89 + 0.66	2.24 + 0.07
Phytate	0.80 + 0.04	0.47 + 0.03
Tannins	0.67 + 0.03	3.63 + 0.07
Flavonoids	1.37 + 0.06	0.72 + 0.04
Oxalate	0.76 + 0.04	0.91 + 0.04