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Nutrient Composition of Detoxified Oil Cake from *Simarouba glauca*

Shafigul Shafiqi[1] and Qiamudin Abad[2]
[1]Department of Agronomy, Faculty of Agriculture, Shaikh Zayed University, AFGHANISTAN.
[2]Department of Agronomy, Faculty of Agriculture, Shaikh Zayed University, AFGHANISTAN.

[1]Corresponding Author: shafigul123@gmail.com

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ABSTRACT

The nutritional composition of Simarouba glauca oil cake was evaluated after applying various detoxification treatments, revealing notable effects on moisture, ash, crude fiber, and carbohydrate contents. Methanol treatments led to an increase in moisture content, while fermentation resulted in elevated levels of ash and crude fiber. Conversely, acetic acid treatment led to increased carbohydrate content compared to the control. Overall, these findings indicate that the nutritional status of Simarouba oil cake is minimally affected by detoxification treatments.

Keywords: Simarouba glauca oil cake, Detoxification treatments, Nutritional composition, Toxic and anti-nutritional factors, and Laboratory experiments.

I. INTRODUCTION

The focus on finding renewable fuel sources as alternatives to fossil fuels has led to significant attention being given to biofuels, particularly biodiesel derived from non-edible oils obtained from trees and plants (Rao, 2003; Rao et al., 1999). Various non-edible oil sources, including *Simarouba glauca*, have been utilized in the production of biodiesel for internal combustion engines (Joshi and Hirmath, 2000). The oil cake obtained from these non-edible oil sources was initially considered unsuitable for consumption due to the presence of toxic substances (Govindaraju et al., 2009; Severen, 1953; Vaughan, 1970; Lassak et al., 1977; Pradhan, 1995). However, it has found valuable use as organic manure in agriculture (Lele, 2010; Bhaskar and Naidu, 2009; Altenburg et al., 2008). In an effort to reduce biodiesel production costs, researchers have conducted experiments to detoxify oil cakes and make them suitable for use as animal feed (Rakshit et al., 2008). Earlier studies have also investigated the characteristics of *Simarouba glauca* oil cake (SOC) and have reported variations in its toxic, nutritional, and other factors based on ecological and location-specific factors (Chikara et al., 1998).

Consequently, investigations were carried out to detoxify the oil cake derived from seeds obtained from plantations located at the University of Agricultural Sciences, GKVK, Bangalore. These studies revealed variations in the levels of toxic and anti-nutritional factors among the different treatment approaches employed. Subsequently, the nutritional composition of the treated oil cake samples, focusing on protein nitrogen, carbohydrates, potassium, phosphorus, crude fiber, and ash contents, was examined. The findings from these investigations are presented in this paper.

II. MATERIAL AND METHODS

In order to develop a straightforward and economical method for the complete or partial detoxification of *Simarouba glauca* oil cake (SOC), a series of experiments were conducted in the laboratory. The expeller-pressed SOC was finely ground, and ten distinct physical and chemical treatments were applied, as outlined below:

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Extraction of residual oil by Soxtherm extraction method:

Seeds of *Simarouba glauca* DC. were gathered from the plantation located at GKVK, and the subsequent oil and oil cake extraction was carried out. The oil cake was accurately weighed, and the extraction process was performed using petroleum ether through the Soxtherm Apparatus. The remaining oil content was expressed as a percentage relative to the weight of the oil cake.

Estimation of moisture content in oil cake:

A predetermined quantity (10 grams) of oil cake samples was subjected to drying at a controlled temperature of 103°C using a thermostatic oven. The resulting dry weight was measured and used to calculate the moisture content, which was expressed as a percentage. This methodology follows the approach outlined by Raghuramulu et al. (2003).

Estimation of ash content in oil cake:

The estimation of ash content in the oil cake samples was conducted following the previously described procedure (AOAC, 1980). The ash content was determined by weight and expressed as a percentage relative to the weight of the oil cake sample.

Determination of crude fiber in oil cake:

The estimation of crude fiber percentage in the oil cake samples was carried out using the method described in AOAC (1980), following the same procedure as previously reported. The crude fiber content was expressed as a percentage based on the weight of the oil cake sample.

Estimation of Nitrogen, Phosphorus & Potassium content in oilcake:

Estimation of nitrogen:

The estimation of total nitrogen content in the oil cake samples was performed through acid digestion, followed by the distillation of ammonia and subsequent titration against an acid, following the methodology outlined in AOAC (1980). The calculation of crude protein content was achieved by multiplying the total nitrogen values by a factor of 6.25, as commonly practiced.

Estimation of phosphorous and Potassium:

To determine the phosphorus and potassium levels in the oil cake samples, a diacid digestion method was employed as described in the earlier works of Jackson (1973) and AOAC (1980). The subsequent analysis involved the use of a spectrophotometer for measuring phosphorus and a flame photometer for quantifying potassium. These established methods and instruments were utilized to accurately assess the phosphorus and potassium content in the oil cake samples.

III. RESULTS AND DISCUSSION

The moisture content of the oil cake samples displayed a decrease when subjected to hydrochloric acid treatment, while methanol extraction treatments resulted in an increase compared to the control. This observation can be attributed to the effects of hydrochloric acid and the hygroscopic nature of residual methanol. Detailed information can be found in Table 1.

The percentage of residual oil in the oil cake samples exhibited a significant reduction following treatments with methanol and sodium hydroxide compared to the control. This decrease can be attributed to the solubility of oil in methanol and the hydrolysis effect of the alkali. Additionally, other treatments employed in this study also led to a reduction in oil content in the treated cake samples, consistent with earlier findings reported by Behura et al. (2008).

The treatments employed had a notable impact on the carbohydrate (CHO) content of the oil cake samples, as shown in Table 1. The carbohydrate levels were reduced to varying degrees in certain treatments, such as boiling (30.29%), roasting (27.29%), and fermentation (27.09%), compared to the untreated control samples (30.49%). However, the samples treated with acetic acid (40.09%) and hydrochloric acid (38.53%) exhibited increased carbohydrate contents and was relatively similar to each other. The reduction in carbohydrates observed in the boiling and fermentation-treated samples can be attributed to the active breakdown of carbohydrates and subsequent energy release. On the other hand, the increase in carbohydrates in the acetic acid and hydrochloric acid-treated samples may be attributed to the conversion of other constituents into carbohydrates.

The percentage of crude fiber (CF) increased in all the treated samples. The fermented samples exhibited the highest levels of crude fiber (3.82%), indicating that soluble carbohydrates might have been converted into insoluble crude fiber during the fermentation process. Roasting, to a limited extent, may have also facilitated the conversion of carbohydrates into crude fiber. It is worth noting that Behura et al. (2008) reported higher levels of crude fiber in sodium hydroxide-treated samples, consistent with our findings.

The ash contents, representing the presence of inorganic nutrients, demonstrated an increase across all treated samples. However, soaking with water and hydrochloric acid treatments resulted in the most significant reduction in ash contents, followed by methanol, acetic acid, and other treatments. These findings align with earlier reports by Behura et al. (2008) that observed similar outcomes regarding the reduction of ash contents through these treatments.

The total nitrogen content (Table 2) and the calculated crude protein (CP) contents in samples treated with fermentation and boiling exhibited increases of 8.03% and 8.02%, respectively, compared to the control value of 7.85%. Conversely, the methanol extraction samples showed reduced values (6.88%), suggesting the partial removal of nitrogenous constituents from the oil cake. However, no drastic reductions were observed in the other treated samples. These findings are consistent with

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previous reports by Bhaskar and Naidu (2009), who also observed similar results.

Potassium, as another essential nutrient, exhibited a reduction in all the treatments. Notably, in samples treated with boiling, fermentation, and soaking with water, there was an almost doubling of potassium levels compared to the control. Conversely, a drastic reduction was observed in the methanol extraction and sodium hydroxide treatments. These findings align with earlier reports by Behura et al. (2008), who also documented similar results regarding the effects of these treatments on potassium content.

The phosphorus contents of the oil cake samples were found to decrease when subjected to acetic acid, fermentation, and water soaking treatments, indicating a reduction in nutrient levels. However, minimal differences were observed in other treatments. Notably, the ammonia-treated + roasting treatment resulted in a slight increase in phosphorus content. Similar effects were reported in earlier studies by Behura et al. (2008).

Overall, the results demonstrate that there was no significant reduction in the various nutrients, oil, carbohydrates, crude fiber, ash, nitrogen, crude protein, phosphorus, and potassium contents in the treated oil cake samples. This suggests that the nutritional status of the treated cake samples was not drastically affected, although there were variations among different treatments. These findings highlight the need for further research to standardize detoxification treatments in order to maintain optimal nutrient levels.

Table 1. Proximate composition of *Simarouba glauca* oil cake in different treatments (per cent):

SI. NO.	Treatments	Moisture	Residual oil	Ash	Crude Fibre	Carbohydrates
1	Control	6.22	9.44	3.75	0.66	30.49
2	Boiling	6.27	8.48	3.98	1.04	30.29
3	Roasting	6.80	8.85	3.68	0.78	27.29
4	Autoclaving	7.33	6.85	3.32	0.86	31.59
5	Soaking with water	6.45	6.85	1.44	0.95	34.28
6	Methanol extraction	10.84	5.37	2.64	0.79	37.04
7	Fermentation	5.97	7.00	8.82	3.82	27.09
8	Acetic acid	6.70	5.73	2.14	1.12	40.09
9	NaOH Treatment	8.56	5.52	3.29	1.10	37.28
10	Roasting after Ammonia	5.25	8.44	3.73	1.03	33.99
11	HCl Treatment	5.17	6.27	1.44	0.94	38.53
	F-value	*	*	*	*	*
	S.Em±	0.11	0.05	0.09	0.04	0.08
	CD at 5%	0.32	0.16	0.25	0.10	0.24
	CV%	2.79	1.29	3.48	5.06	0.40

**Significant at 5% level.*

Table 2. Nitrogen, phosphorus and Potassium of *Simarouba glauca* oil cake in different treatments (percent)

SI.NO.	Treatments	Nitrogen	Crude Protein (CP)	Phosphorus	Potassium
1	Control	7.85	49.06	0.33	0.74
2	Boiling	8.02	50.12	0.34	1.43
3	Roasting	7.93	49.56	0.39	0.38
4	Autoclaving	7.97	49.81	0.32	0.37
5	Soaking with water	7.95	49.68	0.20	1.11
6	Methanol extraction	6.88	43.00	0.24	0.19
7	Fermentation	8.03	50.18	0.20	1.25
8	Acetic acid	7.15	44.68	0.19	0.31
9	NaOH Treatment	7.13	44.56	0.23	0.20
10	Roasting after Ammonia	7.65	47.81	0.47	0.24
11	HCl Treatment	7.61	47.56	0.32	0.35

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	F-Value	*	*	*	*
	Sem±	0.08	0.09	0.01	0.01
	CD at 5%	0.23	0.26	0.02	0.04
	CV%	1.74	0.32	4.12	3.48

**Significant at 5% level*

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