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Physical and Chemical Characterization of Kenaf Seed MH 8234

[1]Abdul Fattah Ab Razak, [1]Mohd Zahid Abidin, [1]Mohd Syafiq Abdullah, [1]Ashraf A. Razak, [1]Mohd Sabri Mohd Afandi, [2]Roselina Karim, [2]Nazamid Saari, [2]Wan Zunairah Wan Ibadillah, [2]Sarina Abdul Halim Lim, [2,3]Nur Aqilah Hamim, [2,4]Shafa'atu Giwa Ibrahim, and [2]Nor Aini Mat Noh

[1]Food Technology Department, School of Engineering Technology, University College of Technology Sarawak (UCTS), 96000 Sibu, Sarawak, Malaysia

[2]Department of Food Science, Faculty of Food Science & Technology, University Putra Malaysia (UPM), 43400 Serdang, Selangor, Malaysia

[3]Food Engineering Section, Malaysian Institute of Chemical & Bioengineering Technology, University Kuala Lumpur (UniKL), 78000 Alor Gajah, Malacca, Malaysia

[4]Department of Biochemistry, Faculty of Science, Usmanu Danfodiyo University Sokoto, P.M.B 2346, Sokoto - Nigeria

Abstract: This study was conducted to determine the physicochemical properties of kenaf seed MH 8234. The analyses were comprised of thermogram, amino acid profile, fatty acid profile, proximate and mineral. In general, these analyses were conducted by using differential scanning calorimetry, high performance liquid chromatography, gas chromatography, atomic absorption spectroscopy. The findings show that kenaf seed MH 8234 denaturation enthalpy, onset and endset temperatures were 99.72 J/g, 99.68 ˚C and 156.55 ˚C. Amino acid profile shows that kenaf seed MH 8234 is rich in L – 4 – hydroxyproline (13.70%), glutamate (3.89%) and arginine (2.02%). This plant material also contains an abundance amount of linoleic acid (8.88%), oleic acid (5.97%) and palmitic acid (4.66%). The nutritional content of kenaf seed MH8234 comprises of crude protein (19.26%), crude fat content (27.32%), ash content (5.17%), moisture content (10.13%) and carbohydrate content (38.12%). The conducted mineral analysis indicates that potassium (1532 mg/ 100g), magnesium (402 mg/ 100g) and calcium (231 mg/ 100g) are major mineral compounds in kenaf seed MH8234. Based on the analyses shows that kenaf seed MH 8234 do have the potential as the main ingredient in products (food, pharmaceutical and nutraceutical).

Keywords: Kenaf seed MH 8234, Physicochemical Properties, Amino Acid Profile, Fatty Acid Profile, Mineral Analysis

INTRODUCTION

Kenaf (Hibiscus cannabinus L.) is part of the Malvaceae family group of Furcuria. Significantly, this plant has been related to okra, cotton, hollyhock and jute [1]. This warm-season annual plant is well known as cordage crop which functions to produce rope, sackcloth, paper, twine, building materials and animals feed [2], [3]. In Malaysia, kenaf has been spotted as a new commodity to replace tobacco plantation. This factor has been supported due to the Malaysian warm and rainy season geographical climate and the willingness of Malaysian government initiative to allocate RM 12 mil for research and development toward kenaf based industry [1], [2].

Kenaf seed (ks) has been considered as waste in agricultural practice [4]. Due to this reason, there are several initiatives taken to promote ks as main ingredient in the food product, such as ks V36 oil for dairy substitute and defatted ks V36 powder for making noodles and kenaf extract KB6 for making tofu [5]–[7]. Fundamentally, the understanding of material physical and chemical characterization is a must towards predicting and designing the potential output.

Recently, researches related to the utilisation of ks have been well studied. However, the physical and chemical characterization of ks MH8234 remain undocumented. Thus, this study was carried out to examine the physical and chemical characterization of ks 8234 which involve the analysis of: thermogram, amino acid profile, minerals, fatty acid profile and proximate.

Corresponding Author: Abdul Fattah Ab Razak, University College of Technology Sarawak (UCTS),
Email: abdul.fattah@ucts.edu.my

MATERIALS AND METHODS

Source of Ks

Ks MH8234 were bought from Zhanpu Zhonglong Kenaf Seeds Co., Ltd, Fujian China and delivered to University College of Technology Sarawak. The sample was kept at a chilled temperature at 4ºC.

Experimental Design

Firstly, ks were undergone physical characterization which involved differential scanning calorimetry analysis. Secondly, ks were undergone chemical characterization through amino acid profile, fatty acid profile, mineral analysis and proximate analysis.

Thermogram analysis

By using differential scanning calorimetry (DSC–823E, Mettler Toledo, GmbH, Switzerland), the thermal properties of ks were calculated according to Brishti et al., 2017. The sample was weighed using analytical balance (Analytical Plus, Mettler Toledo) within the range of (2 – 3 mg) and hermetically sealed in TA pans. The tested TA pans were heated at a heating rate of 10 ° C / minute at 25 to 250 ° C. The calibration was performed with Indium. Mettler state software system version 9.x was employed to measure four components which related to thermal properties: the onset temperature (T_o), the peak temperature (T_d), the enthalpy (ΔH) and the endset temperature (T_e).

Amino Acid Profile

Analysis of amino acids was performed using High Efficiency Liquid Chromatography (Agilent 1220, Agilent Technologies) fitted with UV 338 nm detector, C 18, 2.5 x 200 mm column, 5 µm column and 1:2:2 mobile phase (100mM sodium sulphate, pH 7.2; acetonitrile; 0.45 ml /minute methanol (v/v/v) and 40 °C operating temperature.

Fatty Acid Profile

The ks oil was obtained using Soxhlet extraction unit with utilization of hexane as an extraction solvent. The extracted oil was further added with methanolic NaOH and blanket with N_2. The solution was further heated in the oven at 100°C for 5 min and cool to room temperature. Boron trifluoride was added and blanket with N_2 and well mixed. The solution was heated in the oven at 100°C for 5 min, cooled and filtered through 0.45 µm Whatman® filter paper. The filtered sample was injected to gas chromatography fitted with FID detector, HP – 5 column (30 m x 0.32 mm, 0.32 µm) and pressurized helium gas.

Mineral Analysis

Nine inorganic elements (sodium, calcium, magnesium, iron, potassium, manganese, zinc, copper and phosphorus) of mineral content in the sample were measured according to the method mentioned by [8] using atomic absorption spectrophotometer (240FS AA, Agilent Technologies) .

Proximate analysis

There were five components involved in this analysis, mainly: crude fat, crude protein, moisture content, ash content and carbohydrate content. All conducted methods were referred to [9]. Crude fat was conducted using Soxhlet extraction unit and petroleum ether was employed as lipid extraction solvent. The crude protein of ks is determined by applying Kjeldahl method and 6.25% factors. The moisture content and ash content of ks was measured by calculating the weight difference of sample before and after undergone oven heating at 105˚C for 12 hours and furnace heating at 550˚C for 12 hours. The carbohydrate content was measured by subtracting the content of nutrients from 100.

RESULTS AND DISCUSSION

Table 1: Differential scanning calorimetry (dsc) measurement for Ks MH 8234

Properties	ks MH 8234
Enthalpy (ΔH, J/g)	99.72 ± 0.84
Onset (T_{on} °C)	99.68 ± 0.32 ˚C
Peak (T_d °C)	123.55 ± 0.58 ˚C
Endset (T_d °C)	156.55 ± 0.66 ˚C

Table 2: Amino Acid Composition of ks MH 8234

Amino Acid	**Amount (%)**
Glutamate	3.892
Serine	1.000
Histidine	0.439
Glycine	1.023
Threonine	0.646
Arginine	2.022
Alanine	0.939
Tyrosine	0.540
Valine	0.569
Phenylalanine	0.142
Isoleucine	0.570
Leucine	1.235
Lysine	0.852
Asparagine	ND (<0.001)
Glutamine	ND (<0.001)
Proline	1.276
Aspartate	2.021
L – 4 - Hydroxyproline	13.700

Table 3: Free fatty acid composition of ks MH8234

Free fatty acid	Amount (%)
Caproic Acid (C6:0)	ND (<0.01)
Caprylic Acid (C8:0)	ND (<0.05)
Capric Acid (C10:0)	ND (<0.05)
Undecanoic Acid (C11:0)	ND (<0.05)
Lauric Acid (C12:0)	0.08
Tridecanoic Acid (C13:0)	ND (<0.05)
Myristic Acid (C14:0)	0.08
Myristoleic Acid (14:1)	ND (<0.05)
Pentadecanoic Acid (C15:0)	ND (<0.05)
Cis – Pentadecanoic Acid (C15:1)	ND (<0.05)
Palmitic Acid (C16:0)	4.66
Cis – Heptadecanoic Acid (C17:1)	ND (<0.05)
Palmitoleic Acid (C16:1)	0.14
Heptadecanoic Acid (C17:0)	ND (<0.05)
Stearic Acid (C18:0)	0.74
Elaidic Acid (C18:1n9t)	ND (<0.05)
Oleic Acid (C18:1n9c)	5.97
Linolelaidic Acid (C18:2n6t)	ND (<0.05)
Linoleic Acid (C18:2n6c)	8.88
Gamma Linolenic Acid (GLA)	ND (<0.05)
Arachidic Acid (C20:0)	ND (<0.05)
Eicosenoic Acid (C20:1)	ND (<0.05)
Alpha Linolenic Acid (C18:3n3)	0.05
Heneicosanoic Acid (C21:0)	ND (<0.05)
Eicosadienoic Acid	0.11
Cis – 8, 11, 14 – Eicosatrienoic Acid (C20:3n6)	ND (<0.05)
Behenic Acid (C22:0)	ND (<0.05)
Erucic Acid (C22:1n9)	ND (<0.05)
Arachidonic Acid (C20:4n6)	ND (<0.05)
Cis – 11,14, 17 – Eicoastrienoic Acid (C20:3n3)	ND (<0.05)
Tricosanoic Acid (C23:0)	ND (<0.05)
Eicosapentanoic Acid (EPA) (C20:5n3)	ND (<0.05)
Docosadienoic Acid (C22:2)	0.09
Lignoceric Acid (C24:0)	ND (<0.05)
Nervonic Acid (C24:1)	ND (<0.05)
Docohexaenoic Acid (DHA) C22:6n3	ND (<0.01)

Remarks

1. < - Less than the minimum detection limit reported; ND – Not Detected

Table 4: Mineral composition of ks MH 8234

Minerals	Amount (mg/ 100g)
Sodium, Na	17.50
Calcium, Ca	231.00
Iron, Fe	4.51
Magnesium, Mg	402.00
Potassium, K	1532.00
Manganese, Mn	5.78
Zinc, Zn	6.81
Copper, Cu	1.25
Phosphorus	45.80

Table 5: Proximate composition of ks MH8234

Proximate	Amount (%)
Crude protein	19.26 ± 0.79
Crude fat	27.32 ± 0.26
Ash	5.17 ± 0.67
Moisture	10.13 ± 0.04
Carbohydrate	38.12 ± 0.68

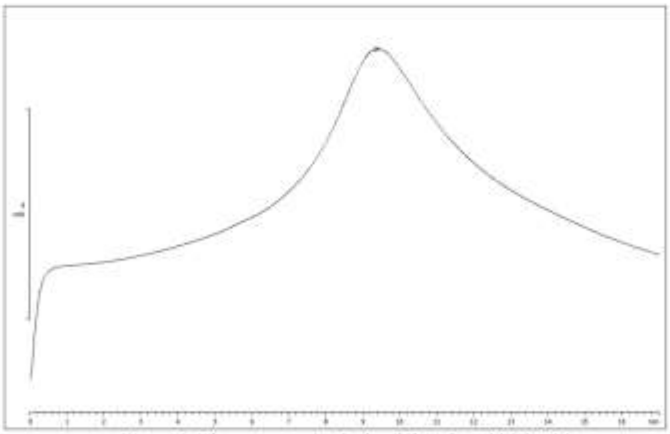
Figure 1: Thermogram Analysis of Kenaf seed MH8234

Thermal Properties of ks

Thermal analysis is conducted to determine the effect of thermal processing on plant protein. Moreover, the data gathered shall provide information about their conformational changes with the temperature of denaturation and this enable researches to predict and evaluate the sample thermal behaviour [10], [11]. The protein denaturation is visualized by the endothermic peak on the thermogram, which occurred due to unfolding of globular proteins and breakage of hydrogen bonds [12]–[16]. The thermal stability is affected by both readings – peak and endset readings. The denaturation enthalpy, onset and endset temperatures of ks MH8234 were 99.72 J/g, 99.68 ˚C and 156.55 ˚C. Disulphide bonds within the protein molecules and the presence of salt bridges are predicted factors towards protein thermal stability [10], [17].

Amino acid profile

The amino acid profile of ks MH 8234 shows that L – 4 – Hydroxyproline (13.70%), glutamate (3.892%) and arginine (2.022%) are the predominant amino acids in ks MH 8234. Table 2 shows that asparagine and glutamine were not detected. According to [18] hydroxyproline is grouped under derived amino acids and this compound was mainly found in collagen. Identically, glutamate or glutamic acid is clustered under acidic amino acids and with the main function as a flavour enhancer which able to produce umami taste. Arginine is a mainly hydrophilic amino acid and mainly found in meats, dairy products and nuts [18].

Fatty acid profile

Table 3 has shwn that linoleic acid (8.88%), oleic acid (5.97%) and palmitic acid (4.66%) are among the predominant fatty acid compound in ks MH8234. Generally, the displayed results percentages of ks MH 8234 fatty acid composition is considered low as compared soybean and sesame seed [19], [20]. On the other hand, the amount of myristic acid of ks MH8234 is greater than soybean (0.08% > 0.06%). Processing treatment, formulation and ks variety are factors that boost the amount of ks fatty acid composition. As evidence [1], through microencapsulation, freeze-drying treatment and addition of stabilizer has generated a desirable amount of fatty acid composition which partly reason for ks oil to be fit as edible oil.

Proximate analysis

Generally, the proximate composition of food source represents the nutritional content of it. These data stood as a benchmark in directing the idea of the source towards food product development [21]. In these experiments, there were five components involved, mainly: crude protein, crude fat, ash content, moisture content and carbohydrate content. In Table 5, the crude protein content, crude fat, ash content, moisture content and carbohydrate content were found to be 19.26%, 27.32%, 5.17%, 10.13% and 38.12%. In comparison with data collected by [22] towards ks QP3 and V36 has revealed that the ks MH 8234 has a greater amount of crude fat, ash content, moisture content and carbohydrate content than both varieties (QP3 & V36). However, ks MH 8234 has the least amount of crude protein as compared to QP3 and V36. As compared to sesame seed, ks MH 8234 has a greater amount of ash and moisture (4.47% and 4.07%). However, it contain a lower amount of crude protein and crude fat than (21.13% and 56.21%) [23]. As being reported by [24] towards the proximate composition of soybean seed show that this oilseed contains a greater amount of crude protein (39.6%) and ash content (5.7%) than ks MH8234. Nevertheless, ks MH 8234 has a greater amount of crude fat as compared to soybean seed (21.4%).

Minerals Composition

The minerals compositions of nutrients in the food source is linked towards the efficiency of body functioning, and the variation distribution mineral composition of plant source is affected by environmental factors and genotypic variations [25]–[28]. Fe and Zn were reported to the essential micronutrients in the human body, while magnesium is needed for muscle development and maintaining blood pressure, phosphorus and calcium are required for bone and teeth formation and sodium is required for maintaining the biological system in human body [25], [29]. The amount of minerals content reported in this study were in the middle range as compared to other types of oilseed. According to Table 4, shows that ks MH 8234 has a rich amount of potassium than a sesame seed (851.35 mg/ 100g). On the other hand, sesame seed contains a greater amount of macrominerals and trace minerals than ks MH 8234 [20]. On the other hand, [24] reported that the soybean mineral composition: Zinc 19 mg/kg and Manganese 57 mg/ kg are higher than ks MH 8234, other compounds such as potassium 21.1 g/kg, magnesium 2.7 g/kg, sodium 0.2 g/kg, calcium 5.3 g/kg and phosphorus 7.5 g/kg are lower than ks MH 8234.

CONCLUSION

This research was conducted to determine the physicochemical properties of ks MH 8234 which comprise of (thermal analysis, amino acid analysis, free fatty acid analysis, proximate analysis and mineral analysis). Based on the findings, it can be translated that ks MH 8234 contains essential compounds towards the human body. Thus, future studies should be focusing on developing suitable products (food, pharmaceutical and nutraceutical) which utilised ks MH 8234 as the main ingredient.

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