Proximate Composition and Mineral Profile of Yellow and Brown Mustard Seeds from Nigeria

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Abstract: The proximate composition and mineral contents of the yellow and brown varieties of mustard seeds were determined using standard procedures of Association of Official Analytical Chemists and Atomic Absorption Spectrometry. The results showed that the brown seed was richer in carbohydrate (37.24%) than the yellow seed (28.42%) while the amount of fat in the yellow (41.99%) was higher than that of the brown (33%) seed. The values of other important nutrients were almost the same. Both samples had very high level of magnesium and low levels of zinc and iron. Flavonoid contents of both samples (21.08 ppm brown and 1.93 ppm yellow) were also high thereby inferring medical significance.

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Introduction

The use of any seed as a source of nutritious food arises from the knowledge of the chemical composition of its flour and other products (Young and Scrimshaw, 1979; Akobundu *et al.,* 1982; Ogungbenle, 2003). The mustard seed belonging to the Cruciferae (Brassicacea) family, has been an important crop around the world, especially in moderate climate. It has always played an important part in the economic and social lives of the people (Xu and Diosady, 2002; Diosady *et al*., 2005; Prapakornwiriya and Diosady, 2008). The different types of mustard seeds have been widely cultivated and used as spice, medicine and a source of edible oil since ancient times (Ildiko *et al*., 2006).

Yellow or white mustard (*Sinapis alba L.*) is commonly grown for the use of its seed as a spice. While the greens are edible and rather tasty, the agronomic value of the plant lies in the seed. The seed, as in other cruciferae, grow within seedpods, each of which contains small (1±1.5 mm diameter) seeds. Currently mustard is only used as a condiment in the Western markets (Xu and Diosady, 2002; Diosady *et al*., 2005; Prapakornwiriya and Diosady, 2008). Flour from the yellow species is used mostly in Europe, while Orienta mustard (*Brassica juncea*) flour is used most commonly in the United State and Japan (Abul-Fadl *et al*., 2011). Mustard consumption in different countries varies according to local food habits (Cuhra *et al*., 2011). However, mustard contains some 30% oil and approximately 25% of a very high quality nutritious protein (Xu and Diosady, 2002; Diosady *et al*., 2005; Prapakornwiriya and Diosady, 2008). In view of worldwide protein shortage, mustard seeds are becoming of increasing importance as a source of edible proteins (Lam *et al*., 2007). The protein is of excellent nutritional quality being rich in lysine with adequate amount of sulphur containing amino acids, limiting amino acids in most of the cereals and oilseed proteins (Tzeng *et al*., 1988). *Sinapis alba* can be used as a source of a wide range of active components including isothiocyanates, phenolics, dithiolthiones and dietary fibre (Hendrix *et al*., 2012). The world-wide production, utilization and industrialization of mustard seeds are increasing owing to its nutritional and medicinal significance (which have been reviewed extensively by Manohar *et al.,* 2009). However, the presence of toxic and anti-nutritional constituents such as glucosinolates, phytates and hulls limits the use of mustard as a source of protein in food products and the oil is unfortunately very rich in erucic acid, which is known to cause heart problems (Xu and Diosady, 2002).

The compositional characteristics of mustard seeds is of prime importance. The chemical composition relates to nutritional significance and health benefits. In spite of this extensive exploitation of mustard, little information has been published about the chemical composition of mustard seed in Nigeria. This is an attempt to analyse the chemical composition of yellow and brown mustard seeds.

Materials and Methods

Materials

Yellow and brown mustard seeds were purchased from a local market in Ile-Ife, Osun State, Nigeria. All chemicals used were of analytical grade. The two varieties of mustard seeds were cleaned by passing through sieve to remove unwanted materials like small stones and fine sand. The raw mustard seed samples were then milled by Alpine mill to the particle size of < 315 µm. All the analyses were carried out at the Central Laboratory Services, Institute of Agricultural Research and Training Obafemi Awolowo University (I.A.R. & T.), Ibadan, Nigeria.

Proximate Analysis

The proximate analysis of the sample for total ash, crude fibre and fat content were carried out using the methods described in AOAC (1990). The moisture content was determined by measuring the mass of the sample before and after the removal of water by evaporation. The nitrogen was determined by Micro Kjedahl method described by Pearson (1976) and the nitrogen content was converted to protein by multiplying by 6.25. Ash and mineral content was by Larrauri (1996). The method of phenol–sulphuric acid as described by Dubios *et al*. (1956) was used for determination of carbohydrate. The total amount of carbohydrate was determined based on a standard calibration curve prepared using glucose. Lipid extraction was carried out with 2.0 g of homogenised mustard seed flour with Soxhlet extractor with 250 ml of petroleum ether and then the solvent was removed by evaporation. Result was expressed as the percentage of lipids in the dry matter of mustard seeds flour. All values in the results w ere means of three determinations.

Mineral Analysis

The minerals were analysed by dry ashing the sample at 55^{o}C to constant weight and digested with 3 M HCI solution. Sodium and potassium were determined by flame photometer using a Perkin-Elmer 2380 Model Atomic Absorption Spectrophotometer. Minerals were quantified on the basis of peak areas and comparison with a calibration curve obtained with corresponding standards. Minerals were expressed as milligrams per 100 g of fresh weight. All values in the results were means of three determinations.

Results and Discussion

Analysis of proximate composition provides information on the basic chemical composition of the yellow (*Sinapis alba or Brassica alba*) and brown (*Brassica campetris*) mustard seeds examined. The compositions are moisture, ash, crude fat, protein, crude fibre, and carbohydrate. These components are crucial to the assessment of the nutritive quality of the food being analysed. Table 1 showed the proximate compositions of the mustard seeds. The moisture level of the samples was comparable to the values reported in the literature (Abu-Fadl *et al*., 2011, Ratanapariyanuch *et al*. 2012). The moisture content of foods or its processed products gives an indication of its freshness and shelf life, and high moisture content subjects food items to increased microbial spoilage, deterioration and short shelf life (Tressler *et al*., 1980; Adepoju and Onasanya, 2008). The moisture content of a fresh fruit is related to its dry matter content (Warner, 2002). From Table 1, the moisture content of brown mustard seeds (3.50 %) was higher than that of yellow seeds (1.49 %), although, in contrary to Abu-Fadl *et al*. (2011) who reported that yellow mustard seeds was higher in moisture content than the brown seed. Going by the report of Adepoju and Onasanya (2008), yellow mustard seed would have higher shelf life than brown mustard seeds. Fibre in the diet is very important, and cannot be neglected because it decreases serum cholesterol levels, risk of coronary heart diseases, hypertension, diabetes, colon and breast cancer (Ishida *et al*., 2000). Crude fibre measures the cellulose, hemicellulose and lignin content of food. High fibre content in diets have been reported to result in increased removal of carcinogens, potential mutagens, steroids, bile acids and xenobiotics by binding or absorbing to dietary fibre components and be rapidly excreted (Ayoola and Adeyeye, 2009). In this work, brown mustard seeds had crude fibre values almost the same as that of yellow mustard seeds. The health promoting benefits of fibre cannot be overemphasized. Since the crude fibre values of the two varieties of mustard seeds were high (almost 10% of the fresh weight), if consumed will aid digestion and absorption processes in the small intestine.

Carbohydrates provide necessary calories in the diets of most people of the world. Brown mustard had a higher carbohydrate value (37.24%) than yellow mustard (28.42%). These values were higher than those reported by other authors (Abu-Fadl *et al*., 2011; Arif *et al*., 2012). A high value of carbohydrates and crude fiber make mustard seeds useful seeds for consumers. The two varieties of the mustard seeds have comparative values of protein 3.26% and 3.25% respectively. The fat content of brown mustard seeds 33.0% was found comparable to the value of white mustard seeds (28-29%) as reported by Ildiko *et al*. (2006), but that of yellow seeds (41.99 %) was very high. The main fatty acid in the traditional mustard varieties is the erucic acid (38% of the total oil content), and about 23% of total oil content is oleic acid (Diosady *et al.,* 2005**)**. Anuradha *et al*. (2012) also reported that mustard seed oil contains 11%

saturated and 89% unsaturated fatty acid, and among the unsaturated fatty acid 18% linoleic and 15% linolenic fatty acid are present. Crude fat determines the free fatty lipids of a product. This property can be used as the basis in determining processing temperatures as well as auto-oxidation which can lead to rancidity (affect flavour of food) (Adeolu and Enesi, 2013).

Mustard seeds of both brown and yellow varieties contained an adequate percentage (17%) of ash. The ash content can provide an estimate of the quality of the product (Adeolu and Enesi, 2013). The high value of the ash is indicative of higher mineral (especially the macro-minerals) content. The ash content was comparatively higher than those reported by Abu-Fadl *et al*. (2011) but lower than that obtained by Arif *et al*. (2012). Differences in variety, period of maturity stage and environmental conditions are significant influence on chemical composition of seeds.

Table 1: Chemical Composition of Yellow and Brown Mustard Seeds

Components	Brown	Yellow
Moisture content (%)	3.50±0.02	1.49±0.01
Crude protein (%)	3.26±0.01	3.25±0.01
Fat (%)	33.00±0.02	41.99±0.01
Ash (%)	16.83±0.01	17.35±0.01
Crude fibre (%)	9.67±0.02	8.98±0.02
Carbohydrate (%)	37.24±0.01	28.42±0.02

(All values given are means of three determinations)

Major minerals like magnesium and minor minerals like manganese, zinc, and iron as well as heavy metals like lead and cadmium contents of mustard seeds were presented in Table 2. These minerals play a major role in structure and function of both plants and animals (Soetan *et al.,* 2010).

Table 2: Some Minerals Contents of Yellow and Brown Mustard Seeds

Minerals (mg/kg)	Brown	Yellow
Magnesium	11.55±0.02	9.95±0.01
Lead	ND	ND
Zinc	0.46±0.01	0.22±0.01
Iron	0.005	0.003
Manganese	ND	ND
Copper	0.81±0.01	ND
Iron	1.03±0.02	1.37±0.02
Cadmium	ND	ND

ND: Not Detected
(All values given are means of three determinations)

The mineral contents of the sample were very high in magnesium, relatively high in zinc, but low in iron (Table 2). Manganese, lead and cadmium were not detected in the two varieties of the mustard seeds analysed. The absence of heavy metals in the analysed mustard seeds indicate that the land on which these mustard seeds was cultivated was not contaminated by heavy metals. Copper was present in the brown variety, but not detected in the yellow variety. Zn plays a vital role in cellular membrane structure and function. It acts as a potent antioxidant and is essential for growth and development of healthy body tissues, proper immune function and regulation of insulin. Distorted enzymatic activity and poor electrolyte balance of the blood fluid are related to inadequate K, Mg, Zn and Na as they are the most required elements of living cells (Ekop, 2007).

The phytochemical screening of both the brown and yellow mustard seeds was carried out on flavonoids in the brown seeds having higher value of 21.08 ppm than yellow seeds which was 1.93 ppm. The availability of flavonoids also inferred that the mustard seeds have some medicinal significance (Farquar, 1996; Okwu, 2004; Abigail *et al*., 2012).

Conclusion

The results of the study show that brown mustard was richer in protein, fat, ash, crude fibre, and flavonoid than yellow mustard.

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