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Effect of *Sesamum indicum L.* seed oil supplementation on hepatic and renal mineral concentrations of hypercholesterolemic rats

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Abstract: Twenty four male rats weighing between 120-130g were randomly assigned into four groups. Group A was fed normal diet; Group B, C and D were fed hypercholesterolemic diet (i.e. 20% fat + 1% cholesterol) for two weeks to establish hypercholesterolemia. Thereafter, Group B were maintained on hyper diet, while C and D were fed 5% and 10% *Sesamum indicum* seed oil supplemented diet for four weeks. The liver and kidney were removed, dried and powdered. The concentrations of iron, zinc, cobalt, manganese, calcium, potassium, magnesium, potassium and sodium were analyzed in both liver and kidney samples with the use of Atomic Absorption Spectrophotometry. Hypercholesterolemia reduced both the hepatic and renal concentrations of sodium, potassium, Phosphorus, magnesium and calcium but reduced the hepatic and not the renal concentrations of manganese and zinc. Supplementation with 5% but not 10% *Sesamum indicum* seed oil reversed the effects and restored the reduced ions concentrations. The hepatic and renal concentrations of Iron and Cobalt ions were not affected by hypercholesterolemia nor by supplementation with *Sesamum indicum* seed oil.

Keywords: Hypercholesterolemia, *Sesamum Indicum*, Liver, Kidney, Mineral Concentration

1. Introduction

Sesamum indicum Linn belongs to the family *Pedaliaceae* and is grown extensively in tropical and subtropical regions of the world mainly for its oil [1]. Total global amount of seed produced was about 2.8 million metric tons (MT) and that of oil about 1.9 MT in 2002 [2]. India is the largest producer of sesame with approximately 27% of its production. China, Myanmar, Mexico, Nigeria, Sudan, Bangladesh, Somalia, and Uganda are other major *Sesamum indicum* producing countries [3]. Several lines of evidence from traditional to modern medicine have confirmed its various medicinal properties [2, 4, 5]. This plant contains significant amount of diverse phytochemicals which have been shown to serve as promising natural antioxidants for both food preservation and medicinal applications [2]. *Sesamum indicum* L. seed oil, which constitutes about 55% of the seed [6] is a rich source of mono and polyunsaturated fatty acids [7] and has been appreciated for its antihypercholesterolemic ability [8, 9].

Cardiovascular disease is the leading cause of death and is responsible for 27.1% of global death (WHOa, 2014). Control of cardiovascular risk factors is thus imperative for reducing the morbidity and mortality of the global population [10]. The primary cause of these vascular diseases is atherosclerosis and subsequent formation of lesions inside the coronary and cerebral arteries [11]. Pathogenesis of atherosclerosis is multifactorial and many modifiable and non-modifiable risk factors have been identified [12]. These risk factors collectively contribute to the development, progression and rupture of atherosclerotic plaques [13]. Of the modifiable risk factors of cardiovascular diseases, hypercholesterolemia; which is estimated to cause 4.5% of global death and 2.0% of global disability adjusted life years [14], is the most important [15].

Minerals are inorganic nutrients that are required in small amounts for proper metabolic function in plant and animals [16]. Minerals play important roles as component of metalloprotein, as component of bones and teeth and as electrolyte [17]. Since liver serves as the major storage [18], and kidney the excretory organs for minerals [19], studies of alteration of mineral in liver and kidney has been of

considerable importance in recent years [20]. It has been demonstrated that dietary supplementation with polyunsaturated fatty acids (PUFAs) improves Calcium balance and bone Calcium content in animals and humans [21]. However, the factors associated with liver diseases and mineral metabolism is still vague [22]. Hypercholesterolemia has been reported to decrease circulatory concentrations of sodium and potassium ions [23, 24]. The present study therefore focuses on the change in liver and kidney concentrations of minerals as albino rats induced with hypercholesterolemia were treated with *Sesamum indicum* seed oil.

2. Materials and Methods

Plant material: Benniseed (*Sesamum indicum L.*) was purchased from Oja-Oba market in Ado-Ekiti. It was identified and authenticated at the Herbarium Section of Plant Science Department, Ekiti State University, Ado-Ekiti, Nigeria. It was cleaned, washed and sundried.

Extraction of oil: Oil was extracted using Soxhlet extractor and n-hexane as the solvent (bpt 40-60 °C). The extracted oil was concentrated in a rotary evaporator.

Experimental procedure: Healthy male albino rats were randomly assigned into four groups (A, B, C and D) comprising of six rats each. Group A served as the normal control while group B, C and D served as the test group. Initially, animals in groups (B, C and D) were fed with 20% fat + 1% cholesterol for two weeks to establish hypercholesterolemia. Thereafter, rats in groups C and D were treated with feed supplemented with 5% and 10% *Sesamum indicum* seed oil respectively they were maintained on these dietary regimen for four weeks while being weighed weekly.

Table 1. *Diet Compositions (g kg-1).*

	A	B	C	D
Corn Starch	290	130	280	230
Soya Meal	510	510	510	510
Sucrose	100	100	100	100
Vitamin-mineral mix	50	50	50	50
Soya bean oil	50	200 (20%)	-	-
Benniseed oil	-	-	50 (5%)	100 (10%)
Cholesterol	-	10 (1%)	10 (1%)	10 (1%)

A -Soya bean oil (positive control)
B -20% fat + 1% cholesterol (negative or hyper control)
C -Beniseed oil (5%) supplemented diet
D -Beniseed oil (10%) supplemented diet
Vitamin-mineral mix composition: Vitamin A. 15,000,000, Vitamin b6 2,350mg, Vitamin b12 11,350mg, Vitamin c 100mg, nicotiannite 16,700mg, calcium pantotherate 5,350mg, potassium chloride 87,000mg, sodium sulphate 212,000mg, sodium chloride 50,000mg, magnesium sulphate 12,000mg, copper sulphate 12,000mg, zinc sulphate 12, 000mg, manganese sulphate 12,000mg, lysine HCl 15,000mg- metronome 1000mg, exponent Q.S 1000g.

Tissues preparation: The feeding trial process lasted six weeks after which the rats were anaesthetized with chloroform after they have been fasted overnight and the liver and kidneywere removed, weighed, and oven dried oven dried at 34-350C for 7 days and powdered.

Biochemical analysis: Powdered dried samples were digested in nitric acid and then dissolved in deionized water. The concentrations of iron, zinc, cobalt, manganese, calcium, magnesium, potassium and sodium were analyzed with the use of Atomic Absorption Spectrophotometer. Phosphorus analysis required burning in excess of oxygen gas before digestion.

Statistical analysis: The results are expressed as mean ± S.D. Analysis of variance was used to test for differences in the groups. Differences were considered to be statistically significant at $P < 0.05$. The diet composition is shown in Table 1.

3. Result and Discussion

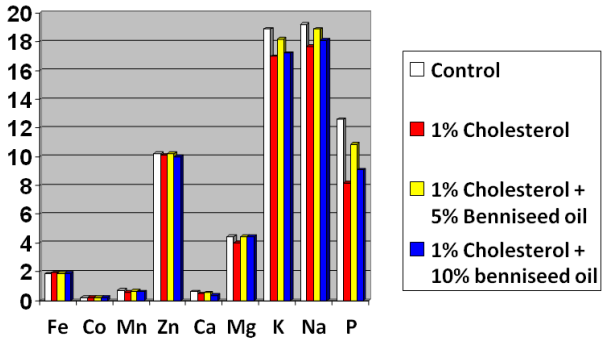

Figure 1. *Liver Mineral Concentrations (In Mg/g) Of Hypercholestesterolemic Rat Supplemented With Benniseed Oil.*

The antihypercholesterolemic effects of *Sesamum indicum* seed oil has been demonstrated by Sedigheh and co worker [9]; as it was shown to maintain normal circulatory levels of apoA and apoB, SGOT, SGPT, glucose and insulin and by Ajayi and co-workers [8]; as it was shown to significantly decrease TC, TG, LDL and LDL/HDL ratio and significantly increase the HDL-C in experimental animals induced with hypercholesterolemia. This study however focuses on the change in liver and kidney concentrations of minerals as albino rats induced with hypercholesterolemia were treated with *Sesamum indicum* seed oil.

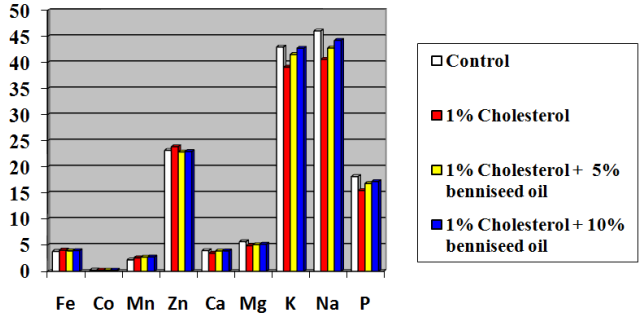

Figure 2. *Kidney Mineral Concentrations (In Mg/G) Of Hypercholestesterolemic Rat Supplemented With Benniseed Oil.*

Sodium and potassium ions being the most predominant

cations in the extracellular and intracellular fluids respectively [25], presents the highest concentrations both in the liver and the kidneys; as depicted correspondingly in Figures 1 and 2. Hypercholesterolemia has been reported to decrease circulatory concentrations of sodium and potassium ions [23, 24]. This is consistent with results obtained in the present study as hypercholesterolemia induced by 1% cholesterol in diet significantly decrease the liver and kidney concentrations of both ions as indicated in Figures 1 and 2 respectively. Administration of *Sesamum indicum* oil reversed the effect and increased the declining ions concentrations; with a more pronounced increment observed in group fed with 5% *Sesamum indicum* oil. Sodium is important to the body because it is necessary for transmission of nerve impulses, heart activity and complementarily with potassium helps in maintaining fluid and electrolyte balance in the body [26, 27]. Phosphorus concentration, both in the liver and kidney, followed the same trend: was reduced by hypercholesterolemia and increased by supplementation of with *Sesamum indicum* oil. Phosphorus is not as concentrated in both organs as sodium and potassium but its required by all forms of life as it plays a role as a component nucleic acids, nucleotides, phosphorylated reaction intermediates, stiffening of bones and as a component of membrane [16, 28]. About 70% of phosphorus in the body is organic and 30% inorganic phosphates [29].

Other minerals that followed the same trend, though to lesser extent, in both organs as did sodium; potassium and phosphorus were magnesium and calcium. Magnesium is essential for every form of life and is present in every cell type [30-32]. ATP, the main source of energy in cells, must be bound to a magnesium ion in order to be biologically active [33]. Calcium plays an important role in signal transduction pathways, where they act as a second messenger [34, 35]. Calcium ions are stored largely in bones and are released from bone into the bloodstream under controlled conditions when need arises [34, 35]. This may be in part the explanation for the relatively low response of calcium concentrations in both liver and kidneys to hypercholesterolemia. Other minerals with the same trend in the liver but not kidney are Manganese and Zinc, both of which are essential trace minerals [36]. The liver and kidney concentrations of Iron and Cobalt ions were not affected by hypercholesterolemia nor by supplementation with *Sesamum indicum* oil.

4. Conclusion

Findings arising from the present studies affirm that the treatment of hypercholesterolemia with *Sesamum indicum* oil poses no threat to hepatic and renal electrolyte concentration and complementarily with previous studies corroborate the antihypercholesterolemic actions of *Sesamum indicum* and the possibility of the use of *Sesamum indicum* oil in the management of clinical conditions associated with hyperlipidemia and hypercholesterolemia.

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