

Evaluation of the Nutrients in Locally Prepared Soups for Optimal Diabetes Control: Evidence from Low Income Communities in Zaria, Nigeria

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Abstract

*A changing pattern towards prevention and complete remission is greatly needed in type 2 diabetes (T2D) care through lifestyle medicine especially healthy diet. The nutritionally valuable macromolecules, minerals and functional properties of benniseed (*Sesamum radiatum*), Melon seed (*Colocynthis citrullus*) and Groundnut (*Arachis hypogea*) soups were studied. Locally prepared soups of these seeds' were analysed based on moisture, ash, lipid, protein, fiber, carbohydrate and minerals using AOAC standard methods. Statistical analysis employed SPSS using frequency and chi-square tools. Manganese, copper, calcium, magnesium, iron and zinc were determined using Atomic Absorption Spectrophotometer (AAS). The results on dry/weight and wet/weight basis showed that protein ranged from 7.04-9.05% versus 22.00-24.13%; moisture 8.5 to 10.6%; ash 6.90-12.33% versus 2.21-3.90%; crude fibre 1.75-2.53% versus 4.66%-7.91%; lipid 19.07%-16.77% versus 50.86%-54.18%; and carbohydrate 1.76-4.34% versus 5.34-12.92% respectively. The predominant mineral was calcium which varied between 4.060 and 8.600 mg/100 g. The samples were low in manganese and copper with moderate concentrations of magnesium, zinc and iron. The proximate analyses of the soups showed optimum abundance to support the management of diabetes mellitus (DM). When intensified with dose adherence, remission may be achieved to reduce DM complications in the environment with challenges attributable to access to health facility.*

Keywords: Benniseed, Melon, Groundnut, Diabetes, Nutrients

INTRODUCTION

Diabetes mellitus (DM) is widely recognized as an emerging epidemic that has a cumulative impact on almost every country, age group, and economy across the world (Ogurtsova *et al.*, 2017). An estimated prevalence of DM among adults aged 20–79 years representing 10.5% of the world's population (IDF, 2021). The number is predicted to rise to 643 million (11.3%) by 2030 and to 783 million (12.2%) by 2045 with about 240 million undiagnosed worldwide majority of which resides in low- and middle income countries including Africa (IDF, 2021). The increase in global health expenditure due to diabetes, as reported by International Diabetes Federation (IDF), will reach USD 1.03 trillion by 2030 and USD 1.05 trillion by 2045 (IDF, 2021). Development of end-stage organ damage such as retinopathy, kidney, non-alcoholic fatty liver and cardiovascular diseases among DM has been reported with highest morbidity and mortality rates (Ades *et al.*, 2015; IDF, 2021).

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The common practice for type 2 diabetes (T2D) management is aiming at delaying the progression rather than remission (Ades *et al.*, 2015). Upon the newly 1.4 million DM adults being diagnosed in US, it is very rare during discussion on treatment options to include intensive whole-food especially plant-based dietary intervention potentially to achieve remission instead of medications or procedures (CDC, 2022). Diet is known to be a driving factor in T2DM morbidity and mortality (GBD, 2017) should therefore be targeted as the primary clinical goal for T2DM management (John *et al.*, 2010). Failure to this quality measures ultimately penalize successful outcomes leading to the development of irreversible chronic illnesses. The American College of Lifestyle Medicine (ACLM) published an expert consensus statement " *Dietary intervention to treat type 2 diabetes in adult with goal of remission* " endorsed by concerned bodies (Ades *et al.*, 2015). The statement focused on the effectiveness of a whole-food, plant-based diet and reduced calorie intake through reduced food volume, portion size, energy density, or a combination of the approaches to promote remission of T2D. They defined remission as normal glycemic measures for at least 3 months without surgery, devices, or active pharmacologic therapy to lower glucose (GBD, 2017). Sufficient and intensive lifestyle interventions may result in T2DM remission as achieved by bariatric surgery at much lower cost without potential complications (Roy *et al.*, 2019). Similar to medication, intensive lifestyle interventions must be dose sufficient to achieve remission compared to prevention of T2DM (Lim *et al.*, 2011).

Food is anything that man eats and serves to maintain life achieved through a nutritionally balance diet (WHO, 2003). Food analysis identify the nutrient content, types and amount to allow supplementation or enhancing effective food choice to achieve treatment or prevention of certain chronic diseases. Today in Nigeria, the prevalence of DM is approximately 5.77% (11.54 million) in 2018 and this is expected to increase by 3% in the year 2020 (Uloko *et al.*, 2018). The yearly cost of diagnosed diabetes in Nigeria was estimated to be \$1-<10 billion, including direct medical costs and in decreased productivity (IDF, 2021). One basic similarity in food pattern of Nigerians is the processing of cereals, starchy roots and tubers into a form of paste (Fufu/Tuwo) which is eaten with soups. The soups are basically prepared with meat or fish (when available), oil, vegetables, crayfish, pepper, onion with other spices and condiments. Some condiments/ingredients are used for special flavour and/or to alter their consistencies using blended seeds of Benni, melon and groundnut seeds, legumes and other nuts. A changing pattern toward prevention and complete remission is greatly needed in T2D care through lifestyle medicine. Diabetes remission requires a healthy diet that is low in carbohydrates, fats, and calories (Roy *et al.*, 2019). More research is needed to determine how well food-as-medicine treatment can maintain remission for the long term. This study aimed to evaluate the proximate composition of commonly prepared soups across Nigeria in an attempt for managing diabetes.

MATERIALS AND METHODS

Soup Samples

The soups materials such as spinach, crayfish, benniseed, melon and groundnut seeds, salt, seasoning, palm-oil, were purchased from Samaru and Sabo markets, Zaria. The preparation of the soups was carried out at the National Agricultural Extension and Research Liaison services (NAERLS), Ahmadu Bello University (ABU), Zaria.

Preparation of melon seed (*Colocynthis citrullus*) soup

A paste of 2 medium size tomatoes, 1 small size onion, 1 medium size pepper were fried in 4 spoonful of palm oil for 5 minutes. Two cups of water was added and allowed to boil. A cube

of seasoning, salt to taste and crayfish were added. A cup of melon (70g blended) was added and followed by a cup of pressed spinach and allowed to cook for 5 minutes.

Preparation of benniseed (*Sesamum radiatum*) soup

A paste of 2 medium size tomatoes, 1 small size onion, 1 medium size pepper were fried in 4 spoonful palm oil for 5 minutes. Two and a half cups of water were added and allowed to boil for (15 minutes). A cube of seasoning, salt to taste and crayfish were added. A cup of benniseed (blended) was added and followed by a cup of pressed spinach and allowed to cook for 5 minutes.

Preparation of groundnut (*Arachis hypogea*) seed soup

A paste of 3 medium size tomatoes, 1 small size onion, 1 medium size pepper were fried in palm for 5 minutes. Three cups of water were added and allowed to boil. A cube of seasoning, salt to taste and 1 tablespoon crayfish were added. A cup of roasted, dehusked and blended groundnut was added and followed by a cup of pressed spinach and allowed to cook for 8 minutes.

Sample Treatment prior to Analysis

The soups were spread over an aluminium container and transferred into an oven pre-heated at 80 °C. The temperature was allowed to cool to 40 °C for complete and steady drying process to conserve valuable nutrients. The dried soups were then grinded in a pestle and mortar to fine powder for subsequent analysis.

Table 1: Characteristics and Composition of the Soup Samples

S/N	English name	Local name	Physical appearance/usage
1	Benniseed (Sesame)	Miyar ridi	Thick, milky colour with suspended clots of cooked benniseed, usually taken with Eba, tuwo, pounded yam etc
2	Melon seed	Miyar Agushi	Thick, milky colour with suspended clots of cooked Egusi-seed, usually taken with tuwo, pounded yam etc
3	Groundnut seed	Miyar Gyada	Thick, milky colour with suspended grinded seed of cooked groundnut-seed, usually taken with tuwo (all types) Gurasa, Al-kubus etc

Determination of Moisture Content

The moisture of the soups was determined following the method reported by AOAC (1975). A clean aluminium foil was ignited in an oven at 80 °C for 30 minutes, cooled to room temperature in a desiccator and weighed. Two (2) g of the sample was transferred in to the pre-dried aluminium container and kept in an oven at 80 °C. The content was dried and cooled to a room in a desiccator. The weight was measured and recorded.

Calculation

$$\% \text{ Moisture} = \frac{\text{lost in weight due to drying}}{\text{weight of sample taken}} \times 100$$

Determination of Ash Content

A porcelain crucible was ignited for 2 minutes in an oven, cooled and weighted (w_1). A 2 gram of the dried powdered sample was measured and transferred into a crucible and weighted again (w_2). The crucible and its contents were heated in an oven until smoke ceased. This was then transferred into a muffle furnace at a temperature of 600 °C for 24 hours. The weight was then taken after attaining a room temperature in the desiccator (w_3).

Calculation

$$\% \text{ Ash} = \frac{\text{Weight of Ash}}{\text{weight of original sample}} \times 100$$

Determination of Lipid Content

The lipid content of the soups was determined following the method reported by AOAC (1984). A 2 g of the dried sample was added into a dry soxhlet thimble which then dried to a constant weight in an oven. The thimble was then connected to the soxhlet tube attached to a weighted flask containing 100 ml of acetone and ethanol (1:1) mixture. A flux condenser was then attached to the soxhlet tube and the round bottom flask heated on a mantle to keep the solvent gently boiling. The solvent vapour was being condensed and ran back onto the food sample in the thimble. When the solvent reached a certain level of the thimble, it was then made to flow back in to the flask through an automatic syphoning device carrying along with it a dissolved fat from the food sample.

The process was allowed to continue for 7 hours and then stopped. The solvent was evaporated in a rotary evaporator and then air dried after which the weight of the flask and its content was recorded.

$$\% \text{ lipid} = \frac{\text{Weight of flask + Extract (Yg)} - \text{Weight of the flask (Zg)}}{\text{weight of original sample (Xg)}} \times 100$$

Determination of Protein (Micro-Kjeldahl Method)

Two (2) g of the powdered sample was weighted in to a 500 mL Kjeldahl flask. Two tablets of Kjeldahl catalyst were added to the flask followed by 25 mL of concentrated sulphuric acid. The flask was then mounted on heating mantle in fume board chamber. Gentle heating was applied until black colour appeared after the temperature was increased as solution clears. The heating process was allowed for 1 hour and 30 minutes and then cooled. It was then transferred in to 250 mL volumetric flask with several washing and made to volume after it was cooled. The content was then shaken thoroughly.

A 5 mL aliquot was distilled in a graduated 50 mL conical flask containing 5 mL 0.1M NaOH (40% sodium hydroxide), until 25 mL of the distillate was obtained. This was then titrated against 0.1M HCL using phenolphthalein indicator. A blank titration was also conducted as control.

Calculation

1 mL of 0.1 M HCL = 1.4g Nitrogen (Oyeleke, 1984)

Hence, the crude protein percentage

$$\% \text{ N} = \frac{\text{volume of sample(A)} - \text{volume of blank(B)}}{\text{Weight of sample(W)}} \times 100$$

$$\% \text{ N} = \frac{1.4 \times 100 \times 100}{1000}$$

$$\% \text{ Crude protein} = \% \text{ N} \times 6.25$$

Determination of Crude Fibre

Two (2) g of the sample was weighted and transferred into a 250 mL quick-fit conical flask and 100 mL of 1.25% H₂SO₄ and a few drop of amyl alcohol as an anti-bumping were added to the flask. A mixture of acetone and alcohol (1:1) was then added and boiled under reflux for 8 hours. The boiled mixture was then filtered through cheese cloth on a Buchner funnel. The residue was washed with 4 portion of 50 mL boiling distilled water. This was again boiled

under reflux with 1.25% NaOH. Filtration was made while hot and the residue was transferred into a dried weighted crucible (W_1). This was then dried in an oven at 100 °C and cooled in a desiccator and weighed (W_2). The dried residue was then ignited in a muffle furnace at 600 °C for 2 hours, cooled in a desiccator and weighed (W_3) (AOAC, 1975).

Calculation:

Weight of fibre = ($W_2 - W_3$)

$$\% \text{ fibre (crude)} = \frac{W_2 - W_3}{\text{Sample Weight}} \times 100$$

Determination of Carbohydrate

The nitrogen free extract (NFE) was estimated by difference obtained after the subtraction of total crude protein, lipid, ash and crude fibre from the total dry matter.

Crude fiber = A

Ash = B

Lipid = C

Crude protein = D

Dry matter = G

The percentage Nitrogen free extract (%NFE) = $G - (A + B + C + D)$

Determination of Mineral Elements

The analytical methods employed was AAS for Manganese, Copper, Calcium, Magnesium, Zinc and Iron.

RESULTS

Table 2: Percentage Chemical Composition of Soup Samples on Wet-Weight Basis

Nutrients	Egusi seed soup	Benni seed soup	Groundnut seed soup
Moisture %	68	68	63
Ash %	3.90	2.21	2.79
Protein (crude) %	7.04	7.68	9.05
Lipid %	16.77	17.34	19.07
Crude fibre %	2.53	2.01	1.75
Carbohydrate %	1.76	2.76	4.34

Table 3: Percentage Chemical Composition of the Soup Samples on Dry-Weight Basis

Nutrients	Melon seed soup	Benni-seed soup	Groundnut seed soup	p-value
Ash %	12.33	6.90	7.43	
Protein (crude) %	22.00	24.06	24.13	
Lipid %	52.42	54.18	50.86	
Crude fibre %	7.91	6.48	4.66	
Carbohydrate %	5.34	8.38	12.92	

Table 4: Mineral Element Concentration using AAS on Dry Sample Matter (mg/100 g)

Mineral elements	Egusi seed soup	Benni-seed soup	Groundnut seed soup
Calcium	8.600	8.000	4.060
Magnesium	1.960	2.912	2.200
Manganese	0.030	0.048	0.034
Zinc	0.127	0.140	0.088
Iron	0.190	0.100	0.080
Copper	0.010	0.028	0.012

Discussion

Results of the proximate composition of the 3 indigenous soups' samples analysed on dry weight basis are shown on Table 3. Previous reports on the nutrient content of the condiment were based on the raw states of melon seeds, benni-seeds and groundnut seeds (Oshodi and Ekunode, 1993; Ene-Obong and Obuotor, 1996; Ogungbenle, 2007). The results presented in this study are based on the composition of the sample in the processed forms in which they are consumed. In this study, the moisture content in the melon and benniseed prepared almost similar despite the fact that the water used during the preparation was different. The similarity is not unexpected as the time of exposure to heat was different. Groundnut soup had the least amount of moisture. This might be attributed to the longer cooking time that caused an increased rate of evaporation and hence led to the fall in its moisture.

The ash content ranged from 6.90 to 12.33% on dry weight basis while on wet-weight basis, the range is between 2.21–3.90%, with melon seed soup having the higher and significant percentage compared to peanut and lastly benni seed soups ($p=0.005$). The ash content being used as an index of minerals present in a sample, still it does not necessarily mean they contain similar or same type of minerals as in unprocessed sample due to evaporation or interaction between the constituents. The result obtained of the ash content shows that melon soup may likely have the highest mineral content.

Crude protein for Benni-seed and groundnut soups are similar on dry weight basis, this is comparable to those of commonly consumed cereals, but differ slightly on wet-weight basis. However, since the nutritive value of protein depends on amino acid composition, especially the amount of essential amino acid content, it is rather difficult from the limited result obtained in this study to predict the quality of the protein or to make any conclusive recommendation (Gorissen *et al.*, 2018).

Carbohydrate content of the assessed soups' samples was low. The implication of the low value is that, the thickening agents in melon-, benni- and groundnut seeds have very low percentage of reducing and non-reducing sugars (Suri and Singh, 2023). The high fat content was observed in all the three soups' samples indicating that these seeds are potential source of vegetable oil. The relatively high fat content may also be attributed to the added palm oil during the processing. The palm oil was added to avoid darkening with time. Oil from non-hydrogenated in plant have been associated with reduced levels of triglycerides, increased levels of high-density lipoprotein (HDL) cholesterol, and improved glycemic control (NRC, 1989). Monounsaturated and omega-3 fatty acids rich oils found in nuts and seeds are preferred over saturated fats in heart and diabetes diseases (Ros, 2010).

The dietary fiber content of the soup samples analysed is considerably very low. Peanut has the least while melon soup had the highest percentage. Fiber is known to support digestive health, reduce risk of cardiovascular disease as it lowers cholesterol and triglyceride and manage T2DM (Soliman, 2019). Increasing consumption of dietary fiber from nuts, seeds, fruit and vegetables, may reduce LDL cholesterol levels. Soluble fiber binds to bile acids, inhibiting the absorption of cholesterol, and improves insulin sensitivity by affecting the rate of carbohydrate absorption (Lattimer and Haub, 2010). Insoluble fiber is beneficial for intestinal motility (McRorie and McKeown, 2017). This will contribute to diabetes management, weight control problems, and imbalances in triglyceride levels (Anderson *et al.*, 2000).

The mineral composition of the three soups' samples showed that calcium had predominated in all the soups' samples. Contributing factors may be from the addition of spinach which has been reported to contain large amount. It can also be due to absorption from water.

Magnesium was abundantly present in the three soups' samples and helps in regulating insulin in converting diabetes (Kostov, 2019). This implies that the soups are good sources of magnesium upon its physiological role in maintenance and regulation of insulin.

The glycemic index (GI) as a measure of how quickly a carbohydrate-containing food raises blood sugar levels, can vary depending on how it is prepared and consumed (Vlachos *et al.*, 2020). Regarding the GI of benni seed, melon seed, and groundnut soups with limited research specifically as soups, generalizations based on the GI of the raw individual ingredients used in these soups may be considered.

Benni seeds had a low glycemic index of around 30 followed by melon seeds with moderate glycemic index of 54 and lastly the groundnut seeds with a moderate to high glycemic index of 14 to 78 relative to whole, flour or butter source. Benni seed soup had a much lower glycemic index. Other ingredients used in the soup such as vegetables, meat and spices may help to lower the overall glycemic index. Factors such as portion size, overall carbohydrate intake and the quality of carbohydrates consumed should also be registered aside glycemic index when making dietary choices for diabetes management (Ludwig *et al.*, 2018). The American Diabetes Association (ADA) recommends that individuals with diabetes should aim for a diet that consists of 45-60% carbohydrates, 15-20% protein and 20-35% fats, with less than 10% of calories coming from saturated fats (Alison *et al.*, 2019; Muhammed *et al.*, 2021).

Consumption of food combination from whole seeds, grains, nuts, legumes, fruits, and vegetables with a diet low in saturated fat and *trans*-fatty acids was encouraged (de-Roos *et al.*, 2001; Ashcherio, 2002). This may significantly decrease cardiac events and mortality among T2DM (Liu *et al.*, 2001; Hu and Willet, 2002; Jacobs *et al.*, 2000; Rissanen *et al.*, 2003; Leterme, 2002) for their effect on LDL and triglyceride levels (Hu and Stampfer, 1999; Bazzano *et al.*, 2001). Legumes such as peanuts, and seeds including sesame seeds, pumpkin or melon seeds contain excellent plant proteins, beneficial fats and soluble and insoluble fiber (Hu *et al.*, 1999; Hu *et al.*, 2001)

CONCLUSION

Melon seeds' soup had reasonably high ash content with probable indication of having high minerals content over others. The high crude fibre was also reported in melon seeds' soup, hence could be recommended to people with non-communicable diseases such as hypertension (HTN) and DM in control of cholesterol level. Groundnut soup on wet-weight basis appropriately contained the richest nutrients required for the daily nutritional requirements for DM patients. Based on the above conclusion, the assessed soup samples can be recommended for people living with diabetes (PLWD) as life style therapy for prevention, treatment or even remission.

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