Effects of Composite Flour Blend Stiff-Porridge on Diabetes Induced Albino Rats

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ABSTRACT

Diabetic patients are challenged with what kind of food they will eat that will not spike their blood glucose level and at the same time also reduce monotony and give them variety. This study focuses on the effects of composite flour blend stiff-porridge on diabetes induced albino rats in Nsukka Local Government Area, Enugu State, Nigeria. Two objectives, research questions and hypotheses were formulated to guide the study. The study was anchored on the theory of Nutrition and related concepts were reviewed. An experimental design was applied, while simple random sampling technique was used to select 90 healthy albino rats with weights that ranges between 197gram to 255gram weight. The study lasted for twenty-one days. The findings of the study revealed that the glycemic response of the diabetic rats fed with the stiff-porridge made with the millet composite flour blend had a positive effect of reduction of hyperglycemia in the diabetes induced albino rats, while Millet has a low glycemic index (GI) that makes it fit as a diabetic meal because its unable to spike blood sugar levels. Based on the findings, the study concludes that the use of selected composite flour blends from locally grown cereals/grains, legumes and plantain to make stiff-porridges could add to the variety of foods (stiff-porridge) for the diabetics and those susceptible to diabetes mellitus who are always complaining of monotony of stiff-porridge whenever hungry. The study therefore recommended that blend of stiff-porridge should be introduced to people with health challenges like diabetes mellitus in Nigeria.

Keywords: Diabetes, Composite Flour Blend, Stiff-porridge, millet , legumes and Plantain, cereals/grains.

INTRODUCTION

Flour is a staple ingredient from either cereals, legumes or tubers that is mostly and commonly used in the production of staple foods like bread, cakes, pastry, pastas and sometimes used to make stiff-porridge for *swallow*. Flour is a powdery substance milled from grains, cereals, legumes, nuts (almond, hazel, coconut, tiger-nut, flax seed, groundnut, cashew-nut amongst others), leaves (moringa leaf, bitter-leaf, cumin leaf, amongst others) and tubers amongst others. Different blends of flours from two or more cereals, legumes and tubers can be mixed to form a common flour which is commonly called composite flour. According to Edet *et al.* (2017), composite flours are produced to satisfy specific functional characteristics that are of economical and rich in nutritional values.

Chandra *et al.* (2015) defined composite flours as mixture of flours from tubers, grains and cereals and pulses that are rich in starch with or without wheat flour. However, composite flour was produced from the combination of blends of flours from selected cereals, legumes and plantain for the production of stiff-porridge like other mono flours. Furthermore, work done on the production of stiff-porridge has been with mono-flour.

Apart from acceptability, the nutritional composition of the stiff-porridge is needed to reveal detailed nutritional information of the nutrient content of the food such as proteins, carbohydrates, fats/oils, vitamins, mineral salts and fibre. The prepared stiff-porridge however, was used to feed diabetes induced albino rats to check its glycemic response on the rats.

Glycemic Response: This is the consequence of food on blood sugar level after consumption. Normally, after the consumption of food the blood glucose will rise and return back to normal after a short period of time. Sadler (2011) opined that the effect of food or meal on blood sugar (glucose) after consumption is glycemic response. The management of glycemic response is the selection of foods that can be used to manage high glycemic response.

Development of Stiff-porridge Recipe: The production of stiff-porridge varies from individuals. It is made: water is set on fire to boil, add the mixed blend flour into the boiling water and stir until the desired viscosity is achieved. Nweke (2014) said the viscosity is achieved and adjusted depending on personal preferences and taste. Stiff-porridge is a recipe that is commonly consumed with the fingers.

Statement of the Problem: Diabetes mellitus is a major public health challenge globally. Worldwide, the prevalence of diabetes mellitus is increasing at an alarming rate especially in Nigeria. In Nigeria, a lot of diabetic patients are challenged with what kind of food (stiff-porridge) they can eat that will not spike their blood glucose level as most staple foods eaten as stiff-porridge are made from mono-flour, carbohydrate dense

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that can easily spikes blood glucose. Moreover, diabetic patients do not have the privilege of eating what they desire due to restrictions on their meals. This has resulted to lack of enthusiasm, excitement and loss of appetite during meal-time mostly when they are hungry and desire to eat stiff-porridge. Hence the present study Effects of selected composite flour blends on the glycemic response of diabetics. This was a drive for the researcher to make use of composite flour blends from cereals (millet and sorghum), legumes (soya bean) and plantain to produce stiff-porridges to feed diabetes induced albino rats. The use of these produced stiff-porridge is to determine their effects on the glycemic response of the diabetic rats.

Purpose of the Study: The study investigated the effects of composite flour blend stiff-porridge on diabetes induced albino rats, the mineral (calcium, iron, manganese, magnesium**,** potassium, selenium, phosphorus and zinc) composition of the composite flour blends and evaluates the effects of the six stiff-porridges on the blood glucose of the diabetic albino rat by the use of glucometer after two hours of consumption.

Research Questions: The following research questions guided the study:

1. What are the minerals (calcium, iron, manganese, magnesium**,** potassium, selenium, phosphorus and zinc) compositions of the composite flour blends?
2. What are the effects of the six stiff-porridges on the blood glucose of the diabetic albino rat by the use of glucometer and glucometer strips on a daily basis?

Research Hypotheses: The following null hypotheses were formulated and tested at P=0.05 levels of significance

H_{01}: There is no significant difference in the mineral (calcium , chromium , iron , iodine , manganese , magnesium **,** potassium and zinc) content of the six composite flour samples.

H_{02}: There is no significant difference in the blood sugar level in the different rats fed with the different stiff-porridges.

MATERIALS AND METHODS

Materials

Albino Rat: Albino rat is a laboratory rat that is bred and kept for scientific research. They are used to enhance learning and a twenty-eight days old rat is remarkably similar to humans. For this study the albino rats were injected with alloxan to infect the rats with hyperglycemia. The infected rats were used to determine the efficacy of selected composite flour used for stiff-porridge products were used as a variety for diabetic patients.

Components of the Composite Flour blends: The components of the flour are cereals/grains such as Millet, Sorghum, Soya-bean and Oat are used in the production of flours respectively. The produced flour are mixed together in a ratio of 2:1:1 to form a composite flour blend sample.

Plantain: Green or unripe plantain is used in the production of flour. The major ingredients or materials in the samples are millet (50%) and sorghum (50%), while plantain flour and soya-bean flour are 25% each in the samples. Each sample is coded as MPSY (50% Millet, 25% Plantain flour and 25% Soya-bean flour) while that of SOPS (50% Sorghum, 25% Plantain and 25% Soya-bean). The samples are same in quantity except for that of MPSP and SPSP that has 1 tablespoonful of palm oil.

Methods of determination of Mineral elements and proximate: Calcium Determination was by EDTA Titration Method Determination of Iron was by Volumetric Method. Various methods are available for the determination and estimation of mineral elements in food. These methods are titrametric method, ion-exchange chromatography, emission spectroscopy, flame photometry, atomic absorption spectroscopy, Glass Electrodes methods and host of others.

Tray: this is used for drying the flour, grain

Biological assessment was done by Sample Collection:

The 90 healthy rats picked from the 110 purchased weighed between 197 - 255grams. The experiment lasted for 21 days but the first 7 days was for acclimatization of the rats while the 7^{th} day was for the inducing of the inducement of hyperglycemia was on the 7^{th} day with alloxan; and the treatment started on the 8^{th} day with the stiff-porridges in five different groups of six.

The blood sample for biochemical assays was collected from the retrobulbar plexus of the median canthus of the rat using a heparinized capillary tube, which was done by the Veterinary Doctor to determine the effect of the stiff-porridge.

Determination of Organoleptic attributes of the stiff-porridges: The instruments for data collection was nine-point hedonic scale form and laboratory test. The organoleptic attributes of the stiff-porridge from the developed composite flour blends were collected using the nine - point hedonic scale.

PRODUCTS INGREDIENTS (g)	MILLET (g)	PLANTAIN (g)	SOYA-BEAN (g)	SORGHUM (g)	PALM OIL (tablespoonful)
Sample A (MPSY)	500	250	250	-	
Sample B (SOPS)	-	250	250	500	
Sample C (MPSP)	500	250	250	--	1
Sample D (SPSP)	-	250	250	500	1

Methods

Composite Flour Blends Production

The production of composite flour blend is the combination of more than one flour mixed together to make one. Crops used are millet, sorghum, soya-bean, and plantain. The use of soya-bean is to enrich the flour with protein. Noorfarahzilah *et al.* (2014) stated that the development of food products using composite flour has increased and also attracted the attention of Researchers, especially in the production of baked products and pastries.

Production of Millet and Sorghum Flour: The grains were bought from the market and sorted for stones and dirt by picking. The grains were washed and sun-dried. The sun-dried grains were milled into flour and sun-dried again to reduce moisture. The flours were canned in airtight containers respectively for later use.

Production of Soya-bean Flour: The soya-bean grain was sorted for stones and dirt's. the sorted grains were washed and sun-dried and roasted for dehulling of the hard coat, and then mill into flour. The milled soya-bean flour was sun-dried again to reduce moisture and heat. The flour was canned in an airtight container. Odedeji and Oyeleke (2011) reported that the production of storable flour whole and dehulled legume will reduce preparation time, cooking time and labour requirement.

Plantain Flour Production: Unripe plantain fingers were washed with the skin, peeled and slice thinly and sundried. Mill the dried slices and sundry again to reduce moisture content and for longevity of the flour. The dried milled plantain flour was canned in an airtight container.

The stiff-porridge is prepared from the prepared composite flour blends from the grains, legume and plantain used in the production of the flour. The stiff-porridges were analysed for mineral composition. The prepared stiff-porridges were used to feed the diabetes induced albino rats to assess glycemic response and for the management of type 2 diabetes mellitus. Diabetes is a degenerative disease and a metabolic disorder that affects the human body that results from the reduction or absence of insulin production for the normal functioning of the body cells. Guariguata *et al.* (2014) stated that most people with diabetes live in low - and middle income countries like Nigeria and these will experience a great increase in cases of diabetes.

The population animal experimentation was 110 albino rats which were bought from the Faculty of Veterinary Medicine and Pathology, University of Nigeria, Nsukka. Simple random sampling technique was used to select 90 healthy albino rats with weights that ranges between 197gram to 255gram weight. The study lasted for twenty-one days. The moisture content of the samples was determined by hot-air oven method according to AOAC (2010). The instruments for data collection was nine-point hedonic scale form and laboratory test. The organoleptic attributes of the stiff-porridge from the developed composite flour blends were collected using the nine - point hedonic scale (see appendix A), while data on nutritional contents (minerals) were obtained from the laboratory analysis of the six stiff-porridge sample treatments. Accu chek and glucometer strip were used for recording the blood sugar level recordings of the rats on the morning of the next day. The instruments of the study were subjected to face validation by three experts, two from the Home Economics and Hospitality Management Education of the Faculty of Vocational and Technical Education, University of Nigeria, Nsukka and one from Department of Home Science and Nutrition, University of Nigeria, Nsukka. They were given the purpose of the study, the research questions and the hypotheses. These experts were expected to review the items in the instrument for clarity, relevance, appropriateness of language and expression including appropriateness of the instruction to the respondents. Modifications were made to accommodate the suggestions that were made by the experts. Also, the developed stiff-porridge from the selected composite flour blends were subjected to face validation by the experts. Data was collected from the two phases in stages for better presentation of information as follows:

Phase 1: Experimental Phase

Stage 2: Determination of Mineral Compositions of the composite flour blends.

Stage 3: Determination of Mineral Compositions of the stiff-porridges.

Stage 4: Determination of the Effect of the stiff-porridges on the glycemic response of the diabetes induced albino rats.

All chemical analysis on the samples were analysed using mean and standard deviation; which was used to answer research questions and analysis of variance (ANOVA) was used to test the hypothesis using statistical package for social sciences (SPSS), version 21. Decision rule: A Null hypothesis was accepted when the probability value is greater than 0.05 ($p>0.05$) and was rejected when the probability value is less than 0.05 ($p<0.05$).

RESULTS AND DISCUSSION

Results

Research Question 1: What are the minerals (calcium, iron, manganese, magnesium, potassium, phosphorus, and zinc) components of the six composite flour blends**?**

Data for answering Research Question 1 is presented in Table 1 and figure 1.

Table 1 contains the mineral composition of the six flour blends. From the analysis, the flour blend with the highest Calcium content was MPSY (12.66±0.00%), followed by CGOP (11.33±0.95%), while the flour blend with the least Calcium content was SPSP (10.66±0.00%). For Iron content, the flour blend with the highest iron content was MPSY (0.98±0.18%), followed by SPSP (0.73±0.17%), while the flour blend with the least iron content were CGOP (0.18±0.08%) and MPSP (0.18±0.08%) respectively. The flour blend with the highest Manganese content was SOPS (1.86±0.22%) followed by CGOS (0.58±0.28%), while the flour blend with the least manganese content was CGOP (0.19±0.27%). For magnesium content, the flour blend with the highest was MPSY (11.72±0.12%) followed by SPSP (11.63±0.19%), while the flour blend with the least magnesium content was MPSP (10.90±0.19%). The flour blend with the highest potassium content was CGOP (0.230.09%), followed by CGOS (0.22±0.00%), while the flour blend with the least potassium content was MPSY (0.10±0.09%).The flour blend with the highest phosphorus content was SOPS (0.71±0.01%); followed by MPSP (0.67±0.01%); while the flour blend with the least phosphorus content was CGOS (0.53±0.01%). For zinc content, the highest was MPSP (0.25±0.00%) both while the flour blend with the least zinc content was SPSP (0.15±0.00%).

Table 1. Mean Value of the Mineral Composition of the Six Composite Flour Blends

Samples	Mineral Compositions of Composite Flour Blends (%)						
	Calcium (Ca) (%)	**Iron (Fe) (%)**	**Manganese (Mn) (%)**	**Magnesium (Mg) (%)**	**Potassium (K) (%)**	**Phosphorus (P) (%)**	**Zinc (Zn) (%)**
100% CGOS	12.00±0.00	0.61±0.00	0.58±0.28	11.29±0.08	0.22±0.00	0.53±0.01	0.20±0.01
CGOP	11.33±0.95	0.18±0.08	0.19±0.27	11.36±0.03	0.23±0.09	0.61±0.01	0.19±0.00
MPSP	11.00±0.47	0.18±0.08	0.46±0.00	10.90±0.19	0.06±0.04	0.67±0.01	0.25±0.00
MPSY	12.66±0.00	0.98±0.18	0.54±0.44	11.72±0.12	0.10±0.09	0.57±0.01	0.23±0.04
SOPS	11.00±2.35	0.61±0.00	1.86±0.22	11.58±0.12	0.11±0.07	0.71±0.01	0.18±0.01
SPSP	10.66±0.00	0.73±0.17	1.47±0.54	11.63±0.19	0.09±0.04	0.65±0.00	0.15±0.00

Key: MPSY = Millet 50%, Plantain 25% and Soya-bean 25%; SOPS = Sorghum 50%, Plantain 25%, Soya-bean 25%; and MPSP = Millet 50, Plantain 25, Soya bean 25 plus 1table spoon palm oil; SPSP = Sorghum 50%, plantain 25%, Soya bean 25% plus 1table spoon palm oil; CGOS = Oat 100%; CGOP = Oat plus 1table spoon palm oil.

Composite bar chart of the mineral composition of the six different composite flour blends

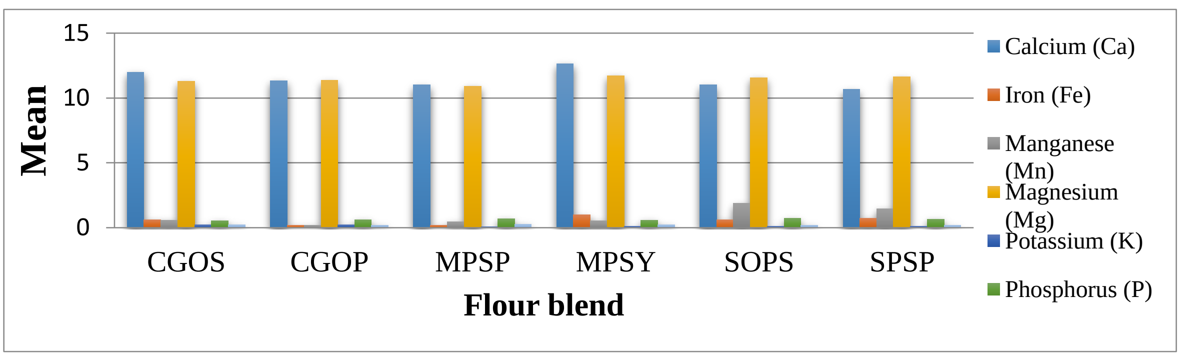

Fig. 1. A composite bar chart of the mineral composition of six different composite flour blends

Hypothesis One: There was no significant difference in the mineral (calcium, chromium, iron, iodine, manganese, magnesium, potassium, and zinc) content of the six samples of flour blends used as composite. Data for testing hypothesis 2 is presented in table 2.

The analytical results in Table 2 contains the ANOVA of the mineral composition of the six flour blends. From the analysis, there was no significant difference in the mineral composition of Calcium (F=1.015, p=0.483) and Potassium (F=2.370, p=0.162 Iron (0.003) respectively whereas there were significant differences in the mineral composition Iron (F=15.82, p=0.00), Manganese(F=7.525, p=0.015), Magnesium (F=9.936, p=0.007), Phosphorus (F=95.87, p=0.00) and Zinc (F=9.813, p=0.007). This is because their probability values were all less than 0.05 level of significant (p<0.05). Therefore, the null hypothesis of no significant difference at 0.05 level of significant was rejected for all but phosphorus and Calcium minerals. This result implies that the mineral content for Calcium and Potassium did not significantly differ in the six composite flour blends but significantly differed for Iron, Manganese, Magnesium, Phosphorus, and Zinc in the composite flour blends.

Research Question 2: What are the effects of the six stiff-porridges on the blood glucose of the diabetic albino rat by the use of glucometer after feeding?

Data for answering Research Question 2 was presented in Table 3 and figure 2**.**

Table 3 contains the mean value of the glycemic response of the diabetic rats which shows that the stiff-porridge from Day-00 had the stiff-porridge sample CGOP with the highest glucose level (534.23±42.32), followed by CGOS (396.72±89.28) while the least was MPSY (267.97±20.07). Day-01 shows that CGOP had the highest figure (460.68±138.37) followed by SPSP (423.90±172.75) and the least was MPSP (194.40±108.53). Day 02 had CGOP (481.90±76.25) had the highest blood glucose followed by CGOS (375.94±101.78); and the least blood glucose was MPSY (161.40±64.11). Day 03 blood glucose measurement has CGOS (476.08±57.10) as the highest followed by SPSP (448.08±160.66); with the least in SOPS (206.46±85.95). Day 04 blood glucose measurement shows that all the groups had blood glucose level low with SPSP (314.28±183.20) having the highest blood glucose level followed by CGOP (278.04±56.76) and the least was MPSP (134.46±45.16). Day 05 showed that the blood glucose level across the group dropped with SPSP (264.78±157.66) as the highest, followed by CGOS (198.90±63.73); and the least was found in the MPSP (98.48±35.21) group. Day 06 of the blood glucose test shows that there is reduction in blood glucose level across the groups. The highest blood glucose test was found in SPSP (149.40±57.67) followed by CGOS (139.26±45.87); and the least was CGOP (94.50±39.83). Day 07 blood glucose testing of SPSP (191.70±88.37) to be the highest followed by CGOS (172.70±24.88); with the least to be MPSP (90.90±44.14). Day 08 shows fasting blood glucose to be high in CGOP (253.35±101.71); followed by SPSP (232.74±100.69); and the least was MPSP (232.74±100.69).

Table 2. The Analysis of Variance (ANOVA) on Mineral Composition of the Six Flour Blends

SAMPLES	ANOVA on Mineral Compositions of Composite Flour Blends (%)						
	Calcium (Ca)	**Iron (Fe)**	**Manganese (Mn)**	**Magnesium (Mg)**	**Potassium (K)**	**Phosphorus (P)**	**Zinc (Zn)**
100% CGOS	12.00±0.00	0.61±0.00	0.58±0.28	11.29±0.08	0.22±0.00	0.53±0.01	0.20±0.01
CGOP	11.33±0.95	0.18±0.08	0.19±0.27	11.36±0.03	0.23±0.09	0.61±0.01	0.19±0.00
MPSP	11.00±0.47	0.18±0.08	0.46±0.00	10.90±0.19	0.06±0.04	0.67±0.01	0.25±0.00
MPSY	12.66±0.00	0.98±0.18	0.54±0.44	11.72±0.12	0.10±0.09	0.57±0.01	0.23±0.04
SOPS	11.00±2.35	0.61±0.00	1.86±0.22	11.58±0.12	0.11±0.07	0.71±0.01	0.18±0.01
SPSP	10.66±0.00	0.73±0.17	1.47±0.54	11.63±0.19	0.09±0.04	0.65±0.00	0.15±0.00
F	1.015	15.924	7.525	9.936	2.370	95.873	9.813
P	0.483	0.002	0.015	0.007	0.162	0.00	0.007
Decision	Not. Sig	Sig.	Sig.	Sig.	Not sig.	Sig.	Sig.

Key: MPSY = Millet 50%, Plantain 25% and Soya-bean 25%; SOPS = Sorghum 50%, Plantain 25%, Soya-bean 25%; and MPSP = Millet 50, Plantain 25, Soya bean 25 plus 1table spoon palm oil; SPSP = Sorghum 50%, plantain 25%, Soya bean 25% plus 1table spoon palm oil; CGOS = Oat 100%; CGOP = Oat plus 1table spoon palm oil; Sig. = Significant, F-value = Calculated value of using SPSS; level of confidence = 0.05.

Table 3. Effects of the six stiff-porridges of the diabetic albino rat with the use of glucometer and glucometer strips

Samples	Vitamin Compositions of Composite Flour Blends (mg/dl)														
	Day00	**Day01**	**Day02**	**Day03**	**Day04**	**Day05**	**Day06**	**Day07**	**Day 08**	**Day09**	**Day10**	**Day11**	**Day12**	**Day13**	**Day14**
CGOS	396.72±8 9.28	406.16± 68.74	375.94± 101.78	476.08± 57.10	278.04± 56.76	198.90± 63.73	139.26 ±45.87	172.70± 24.88	185.94± 24.43	143.64± 10.90	89.56± 21.56	73.44±1 3.83	96.12± 11.43	68.94±3 1.22	188.46±7 5.22
CGOP	534.23±4 2.32	460.68± 138.37	481.90 ±76.25	443.90± 157.05	144.45± 88.75	113.40± 56.88	94.50± 39.83	170.10± 63.02	253.35± 1 01.71	152.78± 66.55	99.90±1 5.02	91.80±4 5.75	147.83 ±79.71	101.25± 19.30	182.13±1 01.40
MPSP	270.54±4 7.25	194.40± 108.53	149.94 ±70.37	286.92± 41.36	134.46± 45.16	98.48±3 5.21	94.86± 32.50	90.90±4 4.14	80.46±3 5.60	87.32±4 1.67	92.16±3 1.34	79.38±1 6.66	87.48± 16.88	79.38±1 6.64	134.28±6 9.01
MPSY	267.97±2 0.07	390.10± 74.13	161.40 ±64.11	237.90± 84.53	159.60± 84.19	122.27± 34.58	96.30± 3.92	119.40± 28.87	148.20± 51.74	119.40± 23.54	107.40± 16.13	99.30±1 7.18	96.90± 17.55	75.00±1 9.75	97.20±11. 80
SOPS	277.54±5 9.75	328.98± 98.34	266.32 ±77.83	206.46± 85.95	176.94± 43.10	135.90± 36.31	113.22 ±51.72	109.26± 1.32	119.52± 33.20	102.96± 23.77	108.18± 22.27	103.82± 14.94	74.88± 13.74	75.06±1 2.91	102.78±1 7.20
SPSP	387.38±7 4.09	423.90± 172.75	139.68 ±48.69	448.08± 160.66	314.28± 183.20	264.78± 157.66	149.40 ±57.67	191.70± 88.37	232.74± 100.69	244.44± 72.26	386.46± 86.04	346.40± 150.46	136.80 ±76.90	173.34± 36.27	197.00±1 47.91

Key: MPSY = Millet 50%, Plantain 25% and Soya-bean 25%; SOPS = Sorghum 50%, Plantain 25%, Soya-bean 25%; and MPSP = Millet 50, Plantain 25, Soya bean 25 plus 1table spoon palm oil; SPSP = Sorghum 50%, plantain 25%, Soya bean 25% plus 1table spoon palm oil; CGOS = Oat 100%; CGOP = Oat plus 1table spoon palm oil.

Day 09 showed fasting blood glucose to be high in SPSP (244.44±72.26); followed by CGOS (143.64±10.90); and the least was found in MPSP (87.32±41.67). Day 10 showed fasting blood glucose to be high in SPSP (386.46±86.04); followed by SOPS (108.18±22.27) and the least was found in CGOS (89.56±21.56). Day 11 showed high fasting blood glucose in SPSP (346.40±150.46); followed by SOPS (103.82±14.94); and the least is found in CGOS (73.44±13.83). Day 12 showed that blood fasting glucose was high in CGOP (147.83±79.71); followed by SPSP (136.80±76.90) with the least in SOPS (74.88±13.74). Day 13 showed that fasting blood glucose was high in SPSP (173.34±36.27); followed by CGOP (101.25±19.30); and the least was found in the group fed with CGOS (68.94±31.22). Day 14 showed that fasting blood glucose was high in SPSP (197.00±147.91) followed by CGOS (188.46±75.22); and the least was found in MPSY (97.20±11.80).

A composite bar chart on the effect of the six stiff-porridges on the glycemic response of the diabetes induced albino rats

Hypothesis 2. There is no significant difference in the mean ratings of the glycemic response of the different diabetes induced albino rats fed with the six stiff-porridges. Data for testing hypothesis 2 is presented in Table 4.

The analysis in Table 4 showed the ANOVA that showed the differences in the mean rating of the diabetic induced albino rats based on the glycemic response of the diabetic albino rats. The result showed that the treatment diets had significant effect on the mean rating of the diabetic induced albino rats based on the glycemic response of the diabetic albino rats for all the days except Day-6, Day-12 and Day-14. Hence, there were significant differences ($p < 0.05$) in the fasting blood glucose (FBG) levels across all the groups except three days mentioned above. Specifically, Day-00 (F=11.647, p=0.00), Day-01 (F=3.103, P=0.03), Day-02 (F=14.847, p=0.00), Day-03 (F=5.627, p=002), Day-04 (F=2.848, p=0.041), Day-05(F=2.959, p=0.036), Day-07 (F=2.857, p=0.040), Day-08(F=4.868, p=0.004), Day-09(F=7.194, p=0.000), Day-10 (F=36.868, p=0.000), Day-11 (F=11.485, p=0.000) and Day-13 (F=12.622, p=0.000) respectively showed significant differences in the glycemic response of the diabetic albino rats based on treatments. However, Day-06(F=1.374, p=0.274), Day-12(F=1.747, p=0.168) and Day-14(F=1.120, p=0.380) respectively showed no significant differences in the glycemic response of the diabetic albino rats based on treatments.

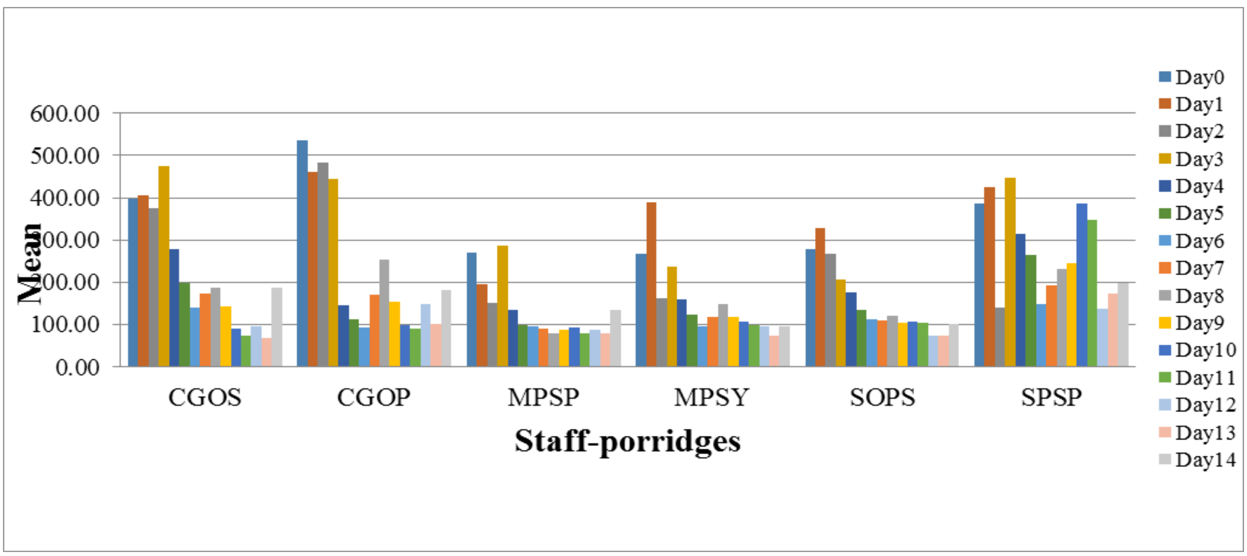

Fig. 2. A composite bar chart on the effect of six stiff porrisges on the blood glucose of diabetic abino rats

Table 4. The analysis of the varies of the mean rating of the glycaemic response of the rats

Samples	Vitamin Compositions of Composite Flour Blends (%)														
	Day00	**Day01**	**Day02**	**Day03**	**Day04**	**Day05**	**Day06**	**Day07**	**Day 08**	**Day09**	**Day10**	**Day11**	**Day12**	**Day13**	**Day14**
CGOS	396.72± 89.28	406.16± 68.74	375.94± 101.78	476.08± 57.10	278.04± 56.76	198.90± 63.73	139.26± 45.87	172.70± 24.88	185.94± 24.43	143.64± 10.90	89.56± 21.56	73.44± 13.83	96.12± 11.43	68.94± 31.22	188.46± 75.22
CGOP	534.23± 42.32	460.68± 138.37	481.90± 76.25	443.90± 157.05	144.45± 88.75	113.40± 56.88	94.50± 39.83	170.10± 63.02	253.35± 101.71	152.78± 66.55	99.90± 15.02	91.80± 45.75	147.83± 79.71	101.25± 19.30	182.13± 101.40
MPSP	270.54± 47.25	194.40± 108.53	149.94± 70.37	286.92± 41.36	134.46± 45.16	98.48± 35.21	94.86± 32.50	90.90± 44.14	80.46± 35.60	87.32± 41.67	92.16± 31.34	79.38± 16.66	87.48± 16.88	79.38± 16.64	134.28± 69.01
MPSY	267.97± 20.07	390.10± 74.13	161.40± 64.11	237.90± 84.53	159.60± 84.19	122.27± 34.58	96.30± 3.92	119.40± 28.87	148.20± 51.74	119.40± 23.54	107.40± 16.13	99.30± 17.18	96.90± 17.55	75.00± 19.75	97.20±1 1.80
SOPS	277.54± 59.75	328.98± 98.34	266.32± 77.83	206.46± 85.95	176.94± 43.10	135.90± 36.31	113.22± 51.72	109.26± 31.32	119.52± 33.20	102.96± 23.77	108.18± 22.27	103.82± 14.94	74.88± 13.74	75.06± 12.91	102.78± 17.20
SPSP	387.38± 74.09	423.90± 172.75	139.68± 48.69	448.08± 160.66	314.28± 183.20	264.78± 157.66	149.40± 57.67	191.70± 88.37	232.74± 100.69	244.44± 72.26	386.46± 86.04	346.40± 150.46	136.80± 76.90	173.34± 36.27	197.00± 147.91
F	11.647	3.103	14.847	5.627	2.848	2.959	1.374	2.857	4.868	7.194	36.868	11.485	1.747	12.622	1.120
P-value	.000	.030	.000	.002	.041	.036	.274	.040	.004	.000	.000	.000	.168	.000	.380
Decision	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Not Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Not Sig.	Sig.	Not Sig.

Key: MPSY = Millet 50%, Plantain 25% and Soya-bean 25%; SOPS = Sorghum 50%, Plantain 25%, Soya-bean 25%; and MPSP = Millet 50, Plantain 25, Soya bean 25 plus 1table spoon palm oil; SPSP = Sorghum 50%, plantain 25%, Soya bean 25% plus 1table spoon palm oil; CGOS = Oat 100%; CGOP = Oat plus 1table spoon palm oil.

Discussion of Findings

The findings of the study were discussed in relation to the research questions and hypothesis that guided the study. The study with respect to research question one established that the mineral composition of the six flour blends indicated that the composite flour with millet is rich in calcium, iron and zinc while sorghum is richer in manganese, magnesium, potassium and phosphorus. This finding is not in support with Oyarekua and Eleyinmi (2004) in the mineral iron (Fe) and is in support with the high amount of magnesium (Mg) and manganese (Mn). Nishizawa, *et al.* (2009) established that millet is a starchy, protein-rich grain that provides more phosphorus, magnesium and calcium than any other cereal.

Test of hypothesis showed that there was a significant difference in the mineral composition of Calcium, Potassium and Iron, Manganese, Magnesium, Phosphorus and Zinc. This is because their probability values were all less than 0.05 level of significant ($P<0.05$). Therefore, the null hypothesis of no significant difference at 0.05 level of significance was rejected for all except for phosphorus and Calcium minerals. This result implies that the mineral content for Calcium and Potassium did not significantly differ in the six composite flour blends but significantly differed for Iron, Manganese, Magnesium, Phosphorus, and Zinc in the flour blends.

The findings of this study established that the glycemic response of the diabetic rats fed with the stiff-porridge made up of millet plantain and soya-bean and that made up of millet plantain and soya-bean with palm oil has a significant effect on the reduction of hyperglycemia in the diabetes induced albino rats. The study of Omoregie and Osagie (2008) also reported GI values for a millet-based food *(tuwo gero)* and a sorghum-based food *(tuwo dawa)* of 93.6 and 85.3, respectively. These values are not significantly different to the findings in the present study (95.2 for millet-based foods and 92.2 for sorghum-based foods). The result of this study is also in corroboration with the result of Jali *et al.* (2012) who established that millets possess antidiabetic properties, due to a study in India that reported that patients with T2D fed with foxtail millet for 90 days showed improved glycaemic control as well as other improvements in this study. The findings of this study is in support with Nagasawa (2009) who stated that cereals like millet and sorghum are good for the diabetic because it has a low glycemic response on the mice. However, it is established that millet induces hypoglycemic effect and improved lipidemic control in diabetic rats and its glycemic index is also higher than that of sorghum. Millet has a low glycemic index (GI) making it unable to spike blood sugar levels (Amanda *et al.*, 2018).

Hypothesis testing of H_{02} established that the treatment diets had significant effect on the mean rating of the diabetic induced albino rats based on the glycemic response of the diabetic albino rats for all the days except for three days which are days 6, 12 and 14. Hence, there were significant differences ($P<0.05$) in the fasting blo

od glucose (FBG) levels across all the groups except three days mentioned above. Sukar *et al.* (2020) reported that there was significant ($P<0.05$) reductions in blood glucose, LDL levels and significant ($P<0.05$) elevation in adiponectin and HDL levels were detected in rats fed with pearl millet which is in support to the result of this study. This study upheld the study by Park *et al.* (2008) established that there is an effect on the glycemic response of diabetic mice.

CONCLUSION

Based on the findings of the study it is obvious that the use of selected composite flour blends from locally grown cereals/grains, legumes and plantain to make stiff-porridges could add to the variety of foods (stiff-porridge) for the diabetics and those susceptible to diabetes mellitus who are always complaining of monotony of stiff-porridge whenever hungry. It is also concluded that the design criteria established was appropriate for the achievement of excellent stiff-porridge as a meal for consumption by the diabetics. This study demonstrates the possibility of reducing or eliminating rapid increase or formation of other health challenges associated to diabetes mellitus. The study finally established the important involvement and contribution of stakeholders which includes lecturers, students, caretakers/caregivers, nutritionists, dieticians and Home Economics lecturers in the selection of cereals/grains, legumes and plantain, in the making of the stiff-porridge and consumption by the diabetics and others susceptible to diabetes mellitus.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

1. Consumers should be enlightened by Home Economists, Nutritionists, Dietitians and relevant authorities on the use of composite flour blends in appropriate ratios because of their improved nutritive value, sensory attributes and general acceptability through seminars, workshops and social medias, television, print medias and radio.
2. Stiff-porridges from selected composite flour blends should be introduced within the health centres and outside for caretakers/caregivers, nutritionists,

dieticians and food and nutrition lecturers and students to adequately inform the diabetic patients.

Suggestions for Further Studies

In view of the findings of this study, the following are suggested for further research:

1. Investigative study should be carried out to establish the extent of managing a diabetic patient with the stiff-porridge.
2. Different other stiff-porridges from other forms of composite flour blends should be made and compared with the one produced in this study in order to ascertain the most appropriate and most effective one in the management of diabetes mellitus.

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الملخص العربي

تأثيرات عصائد من خلطات من الدقيق المركب على جرذان الألبينو المصابه بمرض السكرى

M. Bamson and Ngozi Eze

يواجه مرضى السكر تحديًا في نوع الطعام الذي يتناولونه الذي لا يرفع مستوى السكر في الدم وفي نفس الوقت يقلل أيضًا من الملل ويمنحهم التنوع فى الاطعمه. تركز هذه الدراسة على تقييم تأثيرات ستة أنواع من العصائد بخلطات من الدقيق المركب من الحبوب والبذور والبقوليات على الفئران البيضاء المصابة بداء السكري في منطقة الحكومة المحلية نسوكا Nsukka ، ولاية إينوجو Enugu ، نيجيريا ، وعلى المعادن (الكالسيوم والحديد والمنجنيز والمغنيسيوم والبوتاسيوم والسيلينيوم والفوسفور والزنك) ، وتقييم آثار العصائد الست الصلبة على مستوى الجلوكوز في دم الجرذان عن طريق استخدام مقياس الجلوكوز بعد ساعتين من الاستهلاك. تم صياغة هدفين وتساؤلات بحثية وفرضيات لتوجيه الدراسة. إعتمدت الدراسة على نظرية التغذية وتم مراجعة المفاهيم المرتبطة بها. تم تطبيق المنهج التجريبي ، واستخدام تقنية أخذ عينات عشوائية بسيطة لاختيار ٩٠ فأرًا ألبينو سليما وصحيًا بأوزان تتراوح من ١٩٧ جم إلى ٢٥٥ جم. استمرت الدراسة لمدة واحد وعشرين يومًا.

أظهرت نتائج الدراسة إستجابة الفئران المصابة بداء السكري التى تغذت على عصيدة الدخن ، وكان لخليط الدقيق المركب تأثير إيجابي في تقليل ارتفاع السكر في الدم في الجرذان البيضاء المصابة بداء السكري ، بينما يحتوي الدخن على مؤشر مخفض لنسبة السكر في الدم (GI) مما يجعله مناسبًا كوجبة لمرضى السكرى حيث أنه غير قادر على رفع مستويات السكر في الدم.

بناءً على النتائج ، خلصت الدراسة إلى أن استخدام الدقيق المركب من خليط الحبوب / البذور المزروعة محليًا وخليط البقوليات والقاطونه لعمل عصيدة صلبة يمكن أن يضاف إلى مجموعة الاغذيه المتنوعة لمرضى السكرى وللمعرضين لخطر الإصابة بمرض السكري . مرضى السكرى الذين يشكون دائمًا من الملل من العصيدة كلما شعروا بالجوع. لذلك ، أوصت الدراسة بضرورة تقديم خلطات من العصيدة الصلبة للأشخاص الذين يعانون من تحديات صحية مثل مرض السكري في نيجيريا.

الكلمات المفتاحية: داء السكري – خليط الدقيق المركب – العصيدة الصلبة –الدخن – القاطونة– خليط الحبوب والبذور– خليط البقوليات مع لسان الحمل (القاطونه).