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EFFECT OF MAIZE-CASSAVA-SOYBEAN FLOUR BLENDS INTAKE ON BODY WEIGHT AND POSTPRANDIAL BLOOD GLUCOSE LEVEL OF WISTAR RATS

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Abstract

Effect of maize-cassava-soybean flour blends intake on body weight and postprandial blood glucose level of rats was investigated. The maize – cassava-soybean flours were fed to 15 wistar rats for 21days. Group MF (control) fed on 100 % maize flour; Group MCF fed on 70 % maize flour-30 % cassava flour and Group MCSF fed on 70 % maize flour- 15 % cassava flour-15 % soybean flour respectively. The blood samples of the wistar rats were collected and determined for their blood glucose levels. The result shows that the wistar rats fed on MCSF (70:15:15) had the highest feed intake (70.64 g) compared significantly to those fed 100 % maize flour (68.59 g) and 70:30 % maize-cassava flour(62.92 g). The rats group that fed 70: 30 % of maize-cassava flour blends had the least body weight (152.35 g) while those that fed 70:15:15 % maize-cassava-soybean flour blends had the highest body weight (184.34 g) relative to those that fed 100 % maize flour (164.06 g). The weight gain of the animals fed 100 % maize flour, 70: 30 % maize-cassava flours and 70:15: 15 % maize- cassava-soybean flour blends were 17.03 g, 2.56 g and 37.62 g respectively. Feed conversion ratio of maize-cassava based diet (24.51) was significantly higher than that of 100 % maize diet (3.98) and1.8 of maize- cassava- soybean based diet. The intake of maize-cassava flour supplemented with 15 % soybean reduced postprandial blood levels of the tested rats.

Key words: Weight, Glucose, Postprandial, Fasting, Hyperglycemia

1. Introduction

The cases of cardiovascular disease, diabetes as well as obesity are increasing in many developing countries like Nigeria [1]. The challenges in blood glucose levels are posed to many of these diseases. Blood glucose responses are normally maintained and regulated by hormones like insulin which are usually secreted from the pancreas; however, certain factors like diet and physical activity can cause a change in the blood glucose levels of an individual [2].

The concentration of postprandial has a pivotal role in cardiovascular diseases and diabetes as hyperglycemia is found to contribute many chronic diseases including obesity [1]. The incremental levels of blood glucose are based on the load of carbohydrate intake with the high glycemic load increases blood glucose response. However, low glycemic loads contribute in maintaining the post meal plasma glucose thereby reducing the rate of glucose absorption and metabolizing into the

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blood stream which may be a risk factor for diabetes mellitus [3].

Legumes are found to contain low glycemic index which when compared to cereals, raise the blood glucose level slowly [4]. Legumes are good sources of dietary fiber which in addition have lowering influence on glycemic index. It is relevant to note from the literature that inclusion of fat and protein to a meal containing carbohydrates may result in lower glucose response in the plasma [5]. Composite flours of legume-based are reported to have several bioactive components as well low glycemic index which help in reducing cancer, diabetes, obesity, and cardiovascular diseases [6]. Legume based composite flour also helpful for patients with type 2 diabetes mellitus and the consumption assist in maintaining body mass index, hence, reduced the risk of obesity [6]. The study therefore, examines the effect of maize-cassava-soybeans flour blends intake on the body weight and postprandial blood glucose levels of wistar rats.

2.1 Source of Materials

Maize (SC 649), soybean (TGx 1989-19F) and cassava roots (TME 419) used for this study were procured from farmers at Tse-Igbum Makurdi, Benue State

2.2 Processing of Maize flour

Maize flour was processed as described by Houssou and Ayemor [7]. Maize grains were cleaned and soaked in safe water for 30 min. The soaked grains were drained, rinsed and sun dried and milled into fine powder and packaged for further use.

2.3 Processing of Cassava flour

Cassava flour was produced according to the method described by Adekunle *et al.* [8]. Cassava roots were peeled manually and cut into slices with a sharp stainless knife, washed and soaked in water for 72 h. to ferment. The fermented cassava roots were packed in a sack, dewatered, molded, sundried, milled, sieved and packaged.

2.4 Processing of Soybean flour

Soybean flour was produced according to the method described by Edema *et al.* [9]. The seeds were wet cleaned and steeped in water for 2 h. The steeped soybeans were drained and boiled for 30 min. at 100°C, dehulled manually by rubbing in between the palms and the hulls were removed by rinsing with clean water. The dehulled soybeans were sun dried and milled into flour.

2.5 Experimental Animals and Design

A total of 15 male Wistar rats within the age of 4-8 weeks old weighing between 115-207 grams were used for feeding trial. The Animals were procured from the Animal House Unit at Theosalem Farm North Bank, Makurdi and were housed in a constructed wooden cages in an animal house which were fed with growers feed. The rats were acclimatized for 7 days and weighed before commencement of the feeding trial experiment. After acclimatization period, the animals body weight and blood glucose were determined and served as initial for the feeding trial experiment. The Wistar rats were allocated to MF, MCF and MCSF groups of five (5) rats each, in a well-ventilated cages with facilities for food and clean water. Group MF (control) fed on 100% maize flour; Group MCF fed on 70% maize flour-30% cassava flour and Group MCSF fed on 70% maize flour- 15% cassava flour-15% soybean flour respectively. The animals were allowed access to safe drinking water during the study period. The weight of the animals was taken on a day interval

whereas feed intake was taken on a daily basis using digital weighing balance.

2.6 Determination of Feed intake

Feed intake was monitored every day by weighing back leftover feeds in the buckets and the sum was subtracted from the total weight of the feed allocated to each cage. This was done using digital weighing balance (model; 18189c)

2.7 Determination of Body Weight

The body weight of each rat was assessed using digital weighing balance (model; 18189c) once before commencement of the experiment and was monitored three days in a week in an interval of a day to observe the changes at the end of the experiment.

2.6 Determination of Feed Conversion Ratio (FCR)

$$\textit{Feed Conversion Ratio (FCR)} = \frac{\textit{Total feed Consumed}}{\textit{Weight gain}}$$

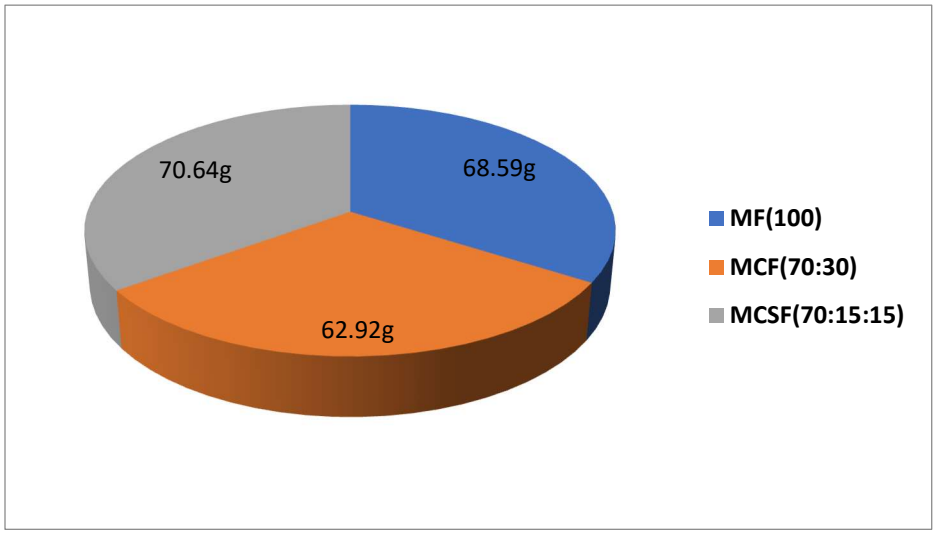
2.8 Determination of Fasting and Postprandial sugar

Fasting Blood Glucose (FBG) was measured after overnight fasting of at least 12 h. using a glucometer (Acute-check, Germany) and glucose test strips. A 2-hour postprandial glucose (PPG) was measured exactly 2 h. after feeding the wistar rats with the formulated meal. Blood glucose curve was drawn from blood glucose response of animals at time 0, after 30, 60, 90 and 120 min intervals after consumption.

3. Ethical consideration

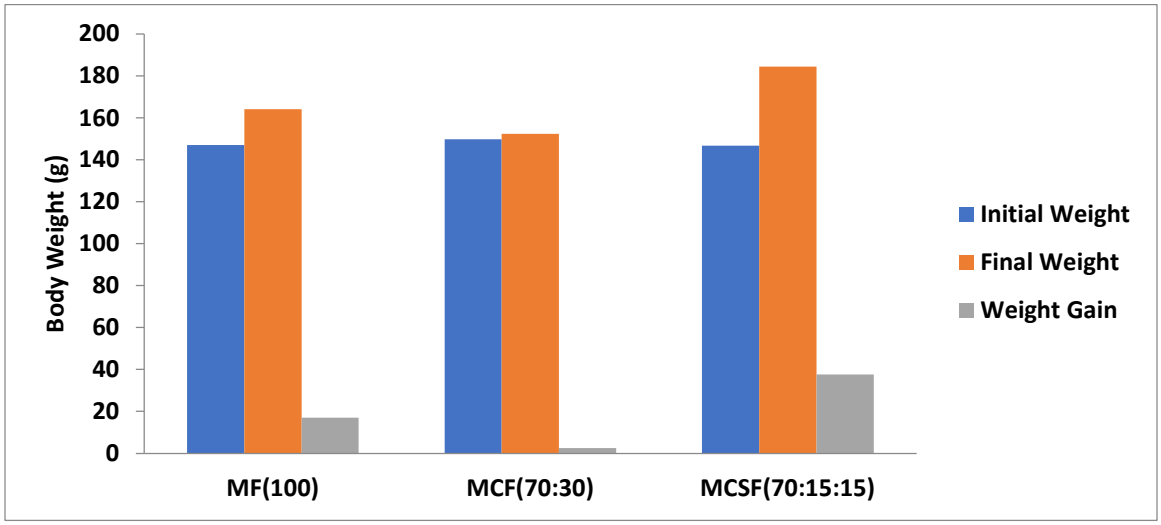
Ethical approval (MOH/STA/204/VOL.1/238) was obtained from Ministry of Health and Human Services, Benue State. The study animals were handled following the rules and regulations guiding use of animals.

4. RESULTS



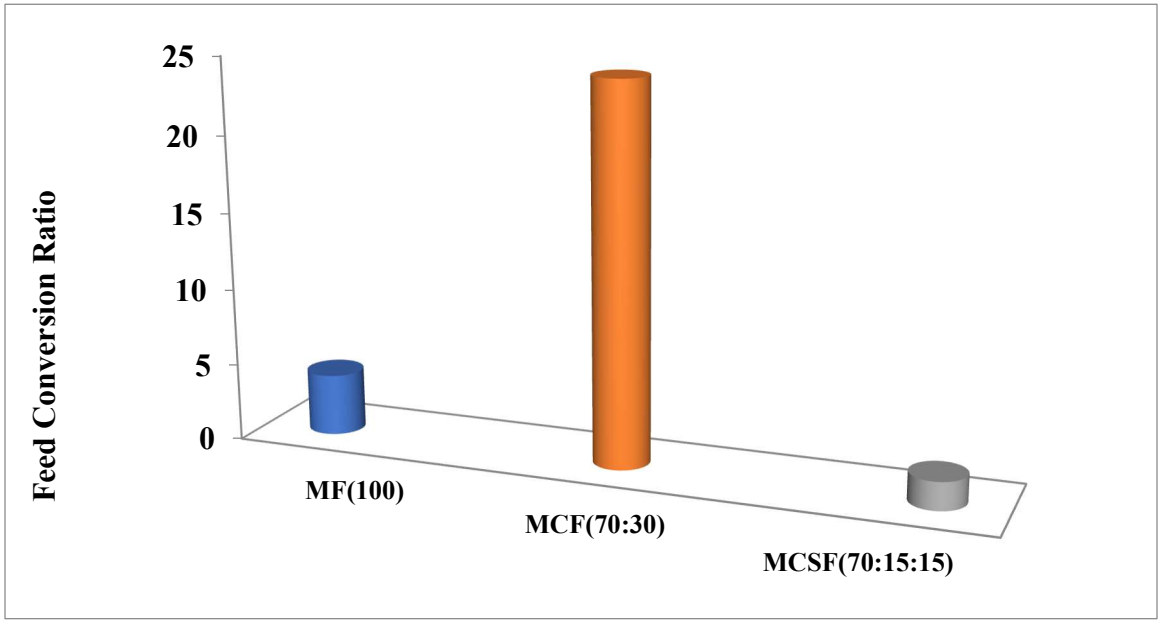
MF=Maize flour, MCF= Maize-Cassava Flour, MCSF= Maize-Cassava-Soybean Flour

Figure 1: Mean feed intake of wistar rats fed maize-cassava soybean flour blends (g)



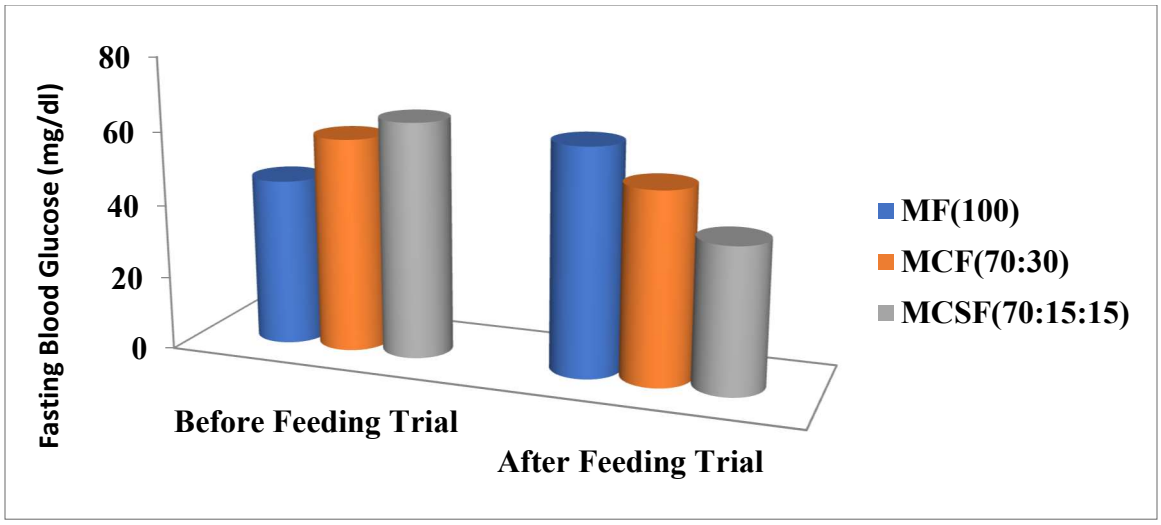
MF=Maize flour, MCF= Maize-Cassava Flour, MCSF= Maize-Cassava-Soybean Flour

Figure: 2 Initial and Final mean body weight of experimental rats fed maize-cassava-soybean flour blends

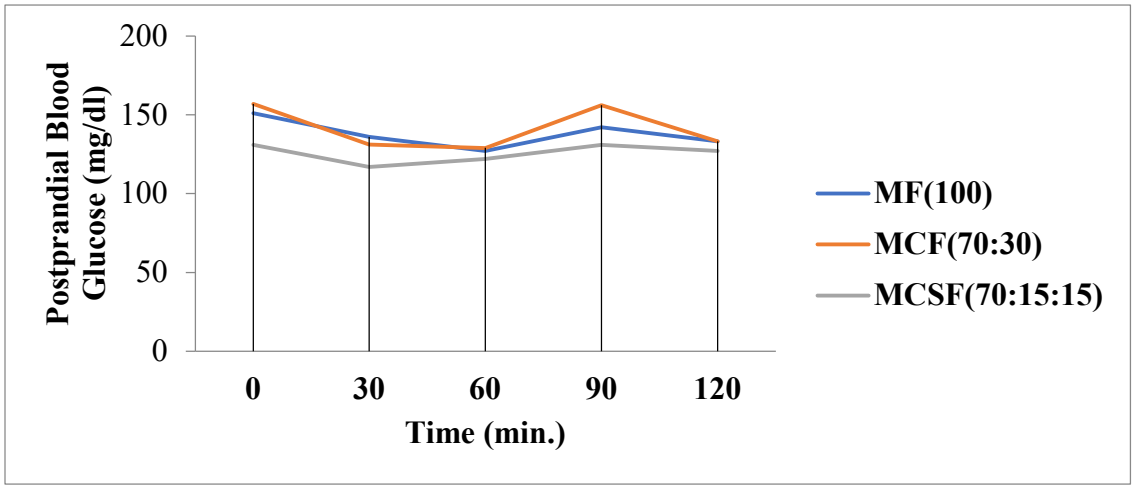


MF=Maize flour, MCF= Maize-Cassava Flour, MCSF= Maize-Cassava-Soybean Flour

Figure 3 Feed Conversion Ratio of experimental wistar rats fed maize-cassava-soybean flour blends



MF=Maize flour, MCF= Maize-Cassava Flour, MCSF= Maize-Cassava-Soybean Flour
Figure 4 Effect of maize-cassava-soybean flour on the Fasting blood glucose level of wistar Rats.



MF=Maize flour, MCF= Maize-Cassava Flour, MCSF= Maize-Cassava-Soybean Flour
Figure 5 Postprandial blood glucose level of Wistar rats before feeding with experimental diet.

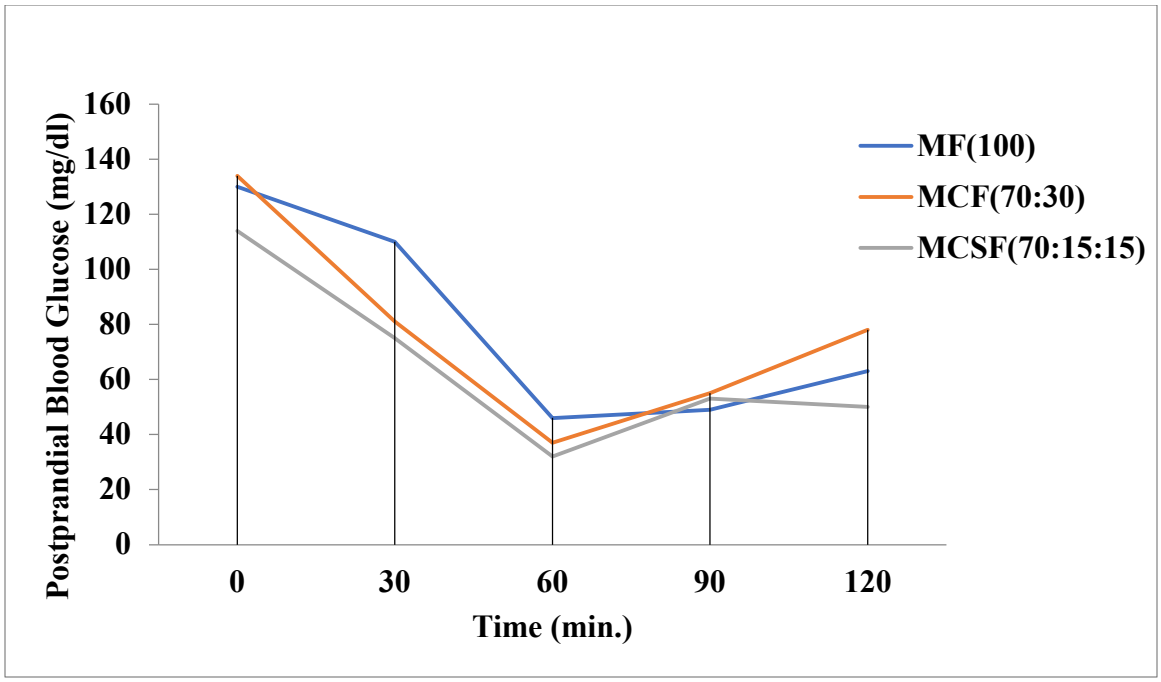


Figure 6 Postprandial blood glucose level of Wistar rats after feeding with maize-cassava-soybean diet.
MF=Maize flour, MCF= Maize-Cassava Flour, MCSF= Maize-Cassava-Soybean Flour

4. DISCUSSION

4.1 Feed intake of rats feed maize-cassava-soybean flour blends

Mean feed intake of different experimental groups is shown in **Figure 1.** The result shows that the wistar rats fed on MCSF (70:15:15) had the highest mean feed intake (70.64 g) while those fed 70:30 % maize-cassava diets had the lowest feed intake of 62.92 g compared significantly to the group of rats fed 100 % maize flour diet z(68.59 g). High consumption of feeds by rats from MCSF (70:15:15) could be due to the pleasant flavor, aroma, palatability and adequate nutrients of soybean while low intake of the group containing 30 % of cassava substitution could be attributed to the unpleasant aroma of the fermented cassava as well as an imbalance of nutrients in cassava flour diet. This unpleasant aroma of fermented cassava has earlier been reported by Ohuoba *et al*. [10] in cassava fufu processing. Oibiokpa *et al.* [11] demonstrated that high levels of anti-nutritional factor, low protein and unpalatability affected food intake of rats.

4.2 Body weight gain of rats fed maize-cassava-soybean flour blends

The result of mean body weight gain of the experimental rats is shown in **Figure 2.**
The weight gain of this present study is directly or indirectly influenced by the dietary protein, fat and feed intake of the wistar rats. The mean weight gain of the experimental rats fed 100 % maize flour, 70: 30 % maize-cassava flours and 70:15: 15 % maize- cassava-soybean flour blends were 17.03 g, 2.56 g and 37.62 g respectively. The body weight gain in the present study is comparably higher than 1.31 to 8.09 g reported by Adeyibi *et al.* [12]. The body weight gained by rats fed 15 % soy flour substitution was significantly higher than weight gained by rats from other groups

while those fed 30 % cassava substitution had the least weight gain (2.56 g). The weight gain witnessed in this study agreed with the previous report of Adeyibi *et al*. [12] who recorded a positive weight gain from a blend of cereals and legumes. The lower weight gain observed in rats fed 30 % cassava flour substitution is expected because cassava flour has low protein and fat which makes the diet inadequate to support growth of the animals [13, 14]. The lower weight gained may also be due to the fermentation of cassava during processing that resulted to poor feed intake due to unpleasant aroma which in turn affects the weight gain. The lower weight gain observed in this study is desirable for those who are suffering from diabetes, overweight and weight watchers. Protein is required for building and maintenance of muscle which in turn contribute to weight gain [15]. However, these attributes of protein and fat were significantly lacking in the cassava-based composite diet. The higher weight gain observed in the rats fed 15 % soybean addition suggests high amount of protein and fat in soybeans that enhanced the growth of the rats [13]. It is clearly understood that, the consistent weight gain by rats fed maize-cassava-soybean was due to high nutrient content of soybean diet as well as high feed intake by the wistar rats. This weight performance exhibited by rats in the present study is in line with earlier report of Bintu *et al.* [16].

4.3 Feed Conversion Ratio of Rats Feed maize-cassava-soybean flour blends

The Feed Conversion Ratio (FCR) of the experimental wistar rats is presented in **Figure 3**. The mean feed conversion ratio of rats fed the formulated diets ranged from 1.80 to 24.51. The FCR of rats fed maize-cassava based diet (24.51) was significantly higher than those fed 100 % maize diet (3.98) and 1.8 of those fed maize- cassava- soybean based diet. The FCR recorded in the current study was lower than FCR values observed by Shiriki *et al*. [17] and Anaemene [18]. The high FCR of rats group fed diet containing 70: 30 % maize- cassava(MCF) indicated inefficiency of the animals to convert the feed into weight gain while those that fed MCSF(70:15:15) of maize-cassava-soybean with lower FCR showed the efficiency of the feed to be converted into weight gain. High FCR is not a desirable quality of both animal and feed while low feed conversion ratio values indicate that a feed is efficiently converted into rat weight gain [19].

4.4 Fasting and Postprandial Blood Glucose Response of rat fed maize-cassava-soybean flour blends

Postprandial blood glucose response of rats after fed experimental diet is presented in Figure **4**. Carbohydrates based foods are ingested and absorbed from the gastrointestinal tracts which are subsequently transported through the portal veins to the liver and to the other parts of the body. This carbohydrate released as glucose functionally provides cells, tissues and organs with energy and then stored as glycogen in the liver and muscles [3]. The improper carbohydrate metabolism result to diabetes mellitus, which is caused by lack of or resistance to insulin leading to hypoglycemia or hyperglycemia. The fasting blood glucose levels of the experimental animals were 61.40 mg/dl (MF), 51.80 mg/dl (MCF) and 39.4 mg/dl (MCSF) respectively. The fasting blood glucose of the present study was lower than 65 to 125 mg/dl reported by Adeoye *et al*. [1]. Fasting blood glucose is an indication of overall glucose balances in the blood. The group of rats fed on diet containing 15 % soybean supplementation had lower fasting blood glucose (39.40

mg/dl). This lower value could be attributed to the addition of soybean to maize-cassava flour in the blends which contain low glycemic index, high protein as well as calcium and magnesium [13]. The low levels (hypoglycemia) indicate liver disease, insulin overdose; severe bacterial infection which resulted to dizziness, sweating and blurred vision while higher concentration (hyperglycemia) is an indication of risk to diabetes, pancreatitis [1]. However, the fasting blood glucose of the study is within the normal range of 50-135 mg/dl except those that fed MCSF and may be desirable for people suffering from diabetes mellitus.

The incremental area under glucose verse intake time is an indication of the blood glucose rise potential. After feeding the respective diets, postprandial blood glucose level rose to the peak from 51.80 to 134 mg/dl (MCF) and 39.40 to114 mg/dl (MCSF) compared to the response of the control(MF) from 61.40 to 130mg/dl) in the first 0 min. of administering the experimental diet. Thereafter, the blood glucose level of all the experimental groups decreased slowly to 30 min. and sharply to 60 min. of intake and started increasing slowly to 120 min. The decreased postprandial blood glucose levels of the present study were lower than the 200 mg/dl reported by Akinjayeju *et al.* [3]. The decrease in the glucose levels is in agreement with Oluwajuyitan and Ijarotimi [20] who reported that plantain flour-based product manages diabetes, reduces the blood glucose level and lower starch digestion rate in the body. The group that fed maize- cassava flour had the highest blood glucose response (134 mg/dl) while the group that fed maize-cassava-soybeans had the least (114 mg/dl) blood glucose response. The higher level of postprandial blood glucose in maize-cassava based diet indicates a high absorption and metabolizing rate of blood glucose which may be a risk for diabetes [3].

Famakin *et al*. [21] reported lower glycemic index and blood glucose level of rats fed composite flour when compared to synthetic antidiabetic drugs. The lower glucose levels observed in rats fed soybean-based diet is attributed to the fact that protein based diet are not easily digested, which however increase the fullness of the stomach thereby delaying the onset of hunger and sugar absorption [22]. This lower postprandial blood glucose level may also be due to the inhibition of glucose, digestion of starch and absorption process of alpha- glucosidase as reported by Inoue *et al.* [5]. It is interestingly to know that, the postprandial blood glucose response of all the experimental groups were within the normal range hence does not have any negative effect for whoever may consume the formulated diet.

5. Conclusion

Feed intake by the animals revealed that the wistar rats preferred the 15 % soybean supplemented diet than 30 % cassava diet. However, all the animals gained weight during the experimental period most especially group MSCF which suggests that the formulated diet supported the growth of the animals.

The intake of maize-cassava flour supplemented with 15 % soybean reduced postprandial blood levels of the tested rats. It is interestingly to know that, the fasting and postprandial blood glucose response of all the experimental groups were within the normal range hence does not have any negative effect for whoever may consume the formulated diet

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