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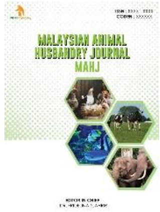

RESEARCH ARTICLE

ADDITIVE INFLUENCE OF MOMORDICA CHARANTIA ON PERFORMANCE AND VISCERAL ORGANS OF DIABETIC GUINEA PIG INDUCED SODIUM GLUTAMATE

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ABSTRACT

This study aimed to assess the additive effect of Momordica charantia (bitter melon) on the lymphoid organs of diabetic guinea pigs induced by sodium glutamate. A total of 24 Guinea pigs were utilized in this 8-week study, randomly assigned to four dietary treatments (T1, T2, T3, and T4), with each treatment comprising 6 Guinea pigs, replicated thrice with 2 Guinea pigs per replicate in a completely randomized design (CRD). Following an eight-week feeding trial, two guinea pigs from each treatment group were euthanized, and their spleen, bile, kidney, heart, and lungs were harvested and weighed. The findings suggested that the additive effect of Momordica charantia (bitter melon) on the lymphoid organ of diabetic guinea pigs generated by sodium glutamate showed no significant alterations in the liver, spleen, kidney, bile, and heart. The gross anatomical and pathological lesions indicate that T4 had the largest frequency of pathological alterations in lymphoid organs, but the examination of hepatic tissues revealed no fluid accumulation, pus, or odor. The findings of this study on the kidneys and lungs revealed necrosis, edema, and hematoma. The treated groups had a significantly darker brown coloration of the liver compared to the control group. Momordica charantia exhibited a significant impact on hepatocytes, hepatocyte height, cholangiocytes, Kupffer cells, endothelial cells, and sinusoids.

KEYWORDS

Sodium glutamate, Diabetic Guinee pig, Momordicata charantia, Lymphoid organ.

1. INTRODUCTION

Diabetes is a metabolic disorder characterized by hyperglycemia, which presents with symptoms including polydipsia, polyphagia, polyuria, visual impairment, and changes in body weight (Zhuo et al., 2020). Consequently, the rise in high-caloric dietary consumption and sedentary behaviour has led to a geometric increase in the number of diabetic patients. A figure from the World Health Organization in 2016 indicates that 422 million individuals had diabetes in 2014, a considerable increase since 1980 (WHO, 2016). Diabetes is typically classified into four categories: type 1 diabetes (T1DM), characterized by autoimmune destruction of β-cells leading to absolute insulin insufficiency; type 2 diabetes (T2DM), marked by a progressive decline in β-cell insulin secretion; gestational diabetes; and particular kinds of diabetes (ADA, 2018). The disease is so chronic that it can damage the heart and blood vessels of any organism the ocular surface, nerves, and the musculoskeletal system gradually, and has become a significant cause of kidney failure and blindness (Koye et al., 2018; Bourne et al., 2013; Sarwar et al., 2010; Markoulli et al., 2018; Rojas et al., 2019; Zamfirov and Philippe, 2017). Insulin injections and oral hypoglycemic medications are consistently employed to lower blood glucose levels. Furthermore, the management of lifestyle is also indicated as vital (Zhuo, et al., 2020). Despite this, inadequate medication adherence and limited access to conventional antidiabetic medications for large populations, coupled with the inevitable side effects and resistance associated with Western medicine, have prompted numerous patients to seek effective natural remedies, such as those found in Indian Ayurvedic medicine, African traditional medicine, Japanese Kampo medicine, and Chinese herbal practices (Furman et al., 2020; Swiatoniowska et al., 2019; Thent et al., 2018).

Momordica charantia L., also referred to as bitter melon, is a perennial climber species belonging to the Cucurbitaceae family (Zhuo et al., 2020). It originates from East India and is extensively cultivated and consumed in tropical, subtropical, and temperate locations globally (Zhuo, et al., 2020). The vegetable is light green, elongated, and conical in shape; it possesses a bitter flavor however is esteemed for its several benefits (Palamthodi and Lele, 2014).

2. MATERIAL AND METHODS

The experiment was carried out at the Livestock Teaching and Research Farm, Federal University Dutsin-Ma, Katsina State. A total of 24 guinea pigs were used for this experiment, which lasted for two months. The Guinea pigs were randomly assigned to four food treatments, designated as T1, T2, T3, and T4, with six Guinea pigs per treatment and three replications, each consisting of two Guinea pigs, in a completely randomized design (CRD). Guinea pigs were administered sodium glutamate (Ajinomoto) during a duration of five days, at dosages of 0g/500ml/kg, 2.5g/500ml/kg, 5g/500ml/kg, and 7.5g/500ml/kg. Mormodica charantia powder was administered at rates of 0g/kg, 0.5g/kg, 0.10g/kg, and 0.15g/kg in the diets designated as T1, T2, T3, and T4, respectively. Mormodica charantia utilized in this study was procured directly from the Wednesday weekly market of Dutsin-Ma Local Government Area, desiccated, and pulverized prior to its incorporation into the diets as appropriate. All management procedures were rigorously followed during the duration of the experiment. Data were gathered on the subsequent growth parameters. Initial body weight (g/bird), final body weight, weight gain (g/bird), total body weight gain (g/bird), average daily body weight gain (g/bird), daily feed intake (g/bird), total feed intake (g/bird), and feed conversion ratio. All acquired data were analyzed using Analysis of Variance (ANOVA) as

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per Steel and Torrie (1980), and means were differentiated employing Duncan's Multiple Range Test (DMRT) according to with the Statistical Analysis Software (SAS) (Duncan, 1995).

3. Result And Discussion

3.1 Proximate Analysis of Momordica Charantia

The data shown in Table 1 indicate that the moisture content of Momordica charantia leaf is 15.0±0.50% DW, which is significantly lower than the reported range of 58.0±2.5 to 93.4±0.7% found in various leafy vegetables (Ladan et al., 1996). Nonetheless, documented elevated range values (81.4 - 90.3%) in several Nigerian green vegetables, potentially attributable to the geographical region and characteristics of the farms from where the samples were sourced (Ifon and Bassir, 1980). The ash content, indicative of mineral composition in biota, is elevated (17.93 ± 0.47%) in Momordica charantia leaves relative to the values documented for Ipomea batatas (1.8%DW) and Corchorus tridens (8.7%) cultivated in Ghana. However, it is comparable to the high ash content observed in certain Nigerian leafy vegetables consumed by lactating mothers, such as bitter leaves, Vernonia colorate (15.86%DW), and Moringa oleifera (15.09%DW). This suggests that Momordica charantia leaves may serve as beneficial suppliers of mineral elements. The crude protein content of the leaves (10.25 ± 0.51%DW) exceeded that of Momordica foetida (4.6%DW) and Momordica involucrata leaves consumed in Swaziland, although was inferior to that of Moringa oleifera (20.72%) and Lesianthera africana leaves (13.1 - 14.9%). Alongside that of M. balsamina (11.29 ± 0.07) Consequently, the leaves of Momordica charantia (14.56%DW) fulfill these criteria. Moreover, adults, children, pregnant women, and breastfeeding moms necessitate daily protein intakes of 34-56g, 13-19g, 71g, and 71g, respectively.

The crude lipid content (3.03±0.76%) was lower than the reported values (8.3±27.0% DW) for several vegetables consumed in Nigeria and the Republic of Niger (Sena et al., 1998). The findings demonstrated that the leaves of Momordica charantia are deficient in plant lipids, corroborating the usual fact that leafy vegetables are low in lipid content, hence promoting health by mitigating obesity risk. The crude fiber content of Momordica charantia leaves (25.31% DW) is significantly higher than the 8.5±20.9% seen in several Nigerian vegetables. The Recommended Dietary Allowance (RDA) for fiber is 19-25% for children, 21-38% for adults, 28% for pregnant women, and 29% for nursing mothers. Consequently, the leaves of Momordica charantia may serve as significant sources of dietary fiber in human nutrition. The estimated carbohydrate content (28.52±0.43%) in Momordica charantia leaves exceeds the 20% found in Senna obtusfolia leaves and the 23.7% in Amaranthus incurvatus leaves, although is lower than that of Momordica balsamina. 29.05 percent. The calorific value of Momordica charantia leaves is approximately 182.35 kcal/100g, which is comparatively lower than the 248.8-307.1 kcal/100g found for many Nigerian leafy vegetables and the 189.22 kcal/100g for Momordica balsamina. This indicates that the plant leaves possess a low calorific value, consistent with the typical fact that vegetables exhibit low energy values.

Table 1: Proximate analysis of Momordica charantia

Parameters	% Composition (DW)
Moisture content	15.00 ± 0.50
Ash content	17.93 ± 0.47
Crude protein	10.25 ± 0.51
Crude lipid	3.03 ± 0.76
Crude fibre	25.31 ± 0.32
Carbohydrates	28.52 ± 0.43
Calorific value(kcal/100g)	182.35

3.2 Physical Anatomical Changes observed in Visceral of Diabetic Induced Rabbit treated with Momordica charantia

The patho-anatomical changes observed in the visceral organs of diabetic induced rabbits treated with Momordica charantia were presented in table 2 below.

Table 2: Physical Anatomical Changes observed in Visceral of Diabetic Induced Rabbit treated with Momordica charantia

Tissue	T1	T2	T3	T4
Liver	No visible lesion, no necrosis but liver color turned dark brown	The hepatic tissue is alright without swollen, odour, or fluid accumulation only liver look excessively dark brown	No visible lesion only liver discolorations was observed	Hepatic congestion and dark brown colored
Kidney	Swollen and hypertrophy kidney was observed	Kidney was swollen with renal congestion	No visible lesion	Kidney was slightly found to have hypertrophy
Heart	No pathological changes in cardiac tissue	No pathological changes in cardiac tissue	Cardiac tissue was normal	No pathological changes in cardiac tissue
Spleen	No changes	Swollen and distension of Spleen was noticed	No visible lesion	No visible lesion
Bile	No visible pathological changes	No visible lesion	Change in colouration of bile fluids	Excessive change in bile content colour
Lungs	There were necrosis, distension and heamatoma in the lungs.	Visible necrosis, change in colour and lesion found in the lungs	Excessive discolouration and heamatoma	The lungs are congested, presence of heamatoma and undefined colour

T1; treatment 1, T2; treatment 2, T3; treatment 3, T4; treatment 4.

3.3 Effect of Momordica charantia on growth performance of Guinea pigs

The growth performance results of the guinea pig are displayed in Table 1 below. The results indicated a substantial (P>0.05) difference in the initial body weight of the guinea pigs, with T4 and T1 exhibiting the greatest weights (307.3 and 302.0 g/kg) among the treatments. The ultimate body weight data indicated significant differences (P>0.05) across the treatments, with T1 exhibiting the highest final body weight (323.3 g/kg), while T2, T3, and T4 recorded lower values of 255.3, 278.7, and 227.0 g/kg, respectively. The weight growth of the Guinea pigs indicated that T4 exhibited the largest increase at 80.33 g/kg, which was substantially different (P>0.05) from the other treatments. All treatments exhibited significant (P>0.05) differences in feed intake, with T3 demonstrating the highest consumption at 44.17 g/kg, while T4 exhibited a superior feed conversion ratio of 2.370 g/kg. The findings of the current study did not align with those of who reported a lower beginning body weight of 154.8 kg per pig in animals fed a diet containing Momordica charantia. However, a greater ultimate body weight of 723.0 kg per pig and an increased average weight gain of 962.154 kg per pig were observed, accompanied by a reduced feed intake of 13.662 kg per pig (Guan et al., 2023). The reported feed conversion ratio was comparable to the feed conversion ratio obtained in the current investigation (2.39).

Table 3: Growth Performance of Guinea pigs

Parameters	T1	T2	T3	T4	SEM	LOS
Initial weight k/dkg	302.0^{a}	235.3^{c}	262.7^{b}	307.3^{a}	51.9	NS
Final weight k/dkg	323.3^{a}	255.3^{b}	278.7^{b}	227.0^{c}	52.9	NS

Table 3 (Cont) : Growth Performance of Guinea pigs						
Weight gain k/dkg	21.33[a]	20.00[a]	16.00[a]	80.33[b]	10.21	*
Feed intake k/dkg	35.00[a]	35.50[a]	44.17[b]	33.92[a]	1.553	*
FCR	0.606[a]	0.553[a]	0.363[a]	2.370[b]	0.306	*

[a-b] means within rows bearing different superscripts differs significantly at p > 0.05; NS= not significant differences (p<0.05) *= significant differences (<0.05) SEM= standard error of means. LSD= least significant differences. T1; treatment 1, T2; treatment 2, T3; treatment 3, T4; treatment 4.

3.4 Effect of Momordica charantia on Diabetic Induced Rabbit Hepatic Tissue Responses

The results indicated substantial differences in all hepatic tissues, except for the space-disse, which showed no significant differences, as reported in Table 4 below. The hepatocytes exhibited the maximum numerical value of 12.00mm at T4 and T3, while the lowest value recorded was 6.00mm at T1.The maximum hepatocyte height (HH) was recorded in T2 (123.0), while the minimum was observed in T3 (103.0).The results indicated that cholangiocytes, stellate cells, and endothelial cells achieved the highest numerical values of 3.000, 1.000, and 3.000, respectively, in T3, while Kupffer cells, bile canaliculi, and sinusoids recorded their highest numerical values in T4 (47.00, 3.000,17.00, respectively).

Momordica charantia, commonly referred to as bitter melon, has historically been employed to address numerous health ailments, particularly diabetes. Studies indicate that Momordica charantia exhibits antidiabetic characteristics, aiding in the regulation of blood glucose levels and enhancement of insulin sensitivity. Research has shown that the bioactive chemicals in Momordica charantia, including charantin, vicine, and polypeptide-p, can lower blood glucose levels and enhance insulin secretion. These chemicals have demonstrated antioxidant and anti-inflammatory properties, which may aid in safeguarding against diabetes complications.

Momordica charantia has been shown to exert a protective impact on hepatic tissue responses. The antioxidants included in the plant may mitigate oxidative stress and inflammation in the liver, which can be compromised by diabetes. Although research on the specific impact of Momordica charantia on hepatic tissue responses in diabetic rabbits is scarce, existing evidence indicates it may effectively lower glucose levels, enhance insulin sensitivity, and safeguard the liver from diabetic complications.

In terms of its effect on hepatic tissue responses, Momordica charantia has been found to have a protective effect on the liver. The antioxidants present in the plant can help reduce oxidative stress and inflammation in the liver, which can be damaged due to diabetes. While there are limited studies on the specific effect of Momordica charantia on diabetic-induced rabbit hepatic tissue responses, the available evidence suggests that it may have a beneficial effect in reducing glucose levels and improving insulin sensitivity, as well as protecting the liver against diabetic complications.

Table 4: Effect of Momordica charantia on Diabetic Induced Rabbit Hepatic Tissue Responses

Parameters	T1	T2	T3	T4	SEM	LOS
Hepatocytes (mm^2)	6.00[c]	7.00[b]	12.00[a]	12.00[a]	0.000	**
Hepatocytes height (μm)	120.0[b]	123.0[a]	103.0[d]	104.0[c]	0.000	*
Cholongiocytes	2.000[b]	0.000[d]	3.000[a]	1.000[c]	0.000	*
Kupffers cells	4.00[d]	27.00[c]	31.00[b]	47.00[a]	0.000	*
Stellate cells	0.000[b]	0.000[b]	1.000[a]	0.000[b]	0.000	*
Endothelial cells	2.000[b]	2.000[b]	3.000[a]	2.000[b]	0.000	*
Bile canaliculi	0.000[c]	0.000[c]	2.000[b]	3.000[a]	0.000	*
Sinusoids	3.00[d]	7.00[b]	6.00[c]	17.00[a]	0.000	*
Spacedisse	0[a]	0[a]	0[a]	0[a]	0	NS

NS= not significant difference (P>0.05) *=significant difference (P<0.05) SEM= standard error of means. LSD= least significant difference. Mean with different superscript are significantly difference. T1; treatment 1, T2; treatment 2, T3; treatment 3, T4; treatment 4.

3.5 Effect of Mormodica charantia on Viscerals of Induced diabetic Guinea Pigs

The result of the effect of Momordica charantia of visceral organs on induced diabetic guinea pig were presented in table 5 below. The result revealed that there were no significant (P<0.05) differences across all the treatments. The result was in agreement with the findings who reported that the visceral values fall within the values reported in the present study (Haruna and Muhammed, 2018).

Table 5: Effect of Mormodica charantia on viscerals of induced diabetic Guinea pigs

Parameters	T1	T2	T3	T4	SEM	LOS
Liver (g)	11.250	8.500	8.250	8.750	2.038	NS
Spleen (g)	0.600	0.500	0.500	0.400	0.180	NS
Bile (g)	0.150	0.200	0.150	0.150	0.043	NS
Heart (g)	1.350	1.050	1.600	1.050	0.290	NS
Kidney (g)	1.300	1.300	1.150	1.200	0.207	NS

a-b means within rows bearing different superscripts differs significantly at p > 0.05; NS= not significant differences (p<0.05) *= significant differences (<0.05) SEM= standard error of means. LSD= least significant differences. T1; treatment 1, T2; treatment 2, T3; treatment 3, T4; treatment 4.

The effect of Momordica charantia on visceral weight of induced diabetic Guinea pig is presented in table 3 below. The result showed that there were no significant (p<0.05) differences across all the treatments. but there were numerical differences among them.

The result of the present study was not in conformity with the finding of Yahayya et al. (2024) who reported significant (P<0.05) differences in liver and spleen weight. Yahayya et al. (2024) restated that the significant (P<0.05) of these internal organs might be attributed to variation of physiological activities of the organs due to the varied level of inclusion of M. charantia in the diet across all the treatments. The findings of Yahayya et al. (2024) further indicated a contradicting value were no significant (P>0.05) differences were recorded in the heart, kidney and bile parameters. The result was in agreement to the findings where the visceral organs values fall within the values reported in this study of (Haruna and Muhammad, 2018).

Table 6: Effect of Momordica charantia on The Visceral Weight of Induced Diabetic Guinea Pig

Parameters	T1	T2	T3	T4	SEM	LOS
Bile (g)	0.150	0.200	0.150	0.150	0.061	NS
Spleen (g)	0.600	0.500	0.500	0.400	0.225	NS
Liver (g)	11.250	8.500	8.250	8.750	2.880	NS
Heart (g)	1.350	1.050	1.600	1.050	0.411	NS
Kidney (g)	1.300	1.300	1.150	1.200	0.294	NS

a-b means within rows bearing different superscripts differs significantly at p > 0.05; NS= not significant differences (p<0.05) *= significant differences (<0.05) SEM= standard error of means. LSD= least significant differences. T1; treatment 1, T2; treatment 2, T3; treatment 3, T4; treatment 4.

4. Conclusion

It could be concluded that M. charantia can be used to modulate and normalized growth performance, carcass characteristics parameters in diabetic induced guinea pigs without any detrimental effect. Supplementation of M. charantia have influenced in reducing visceral organs damage and significant pathological lesion in diabetic induced guinea pigs. It also plays significant role in the improvement of liver cells (hepatocytes) and other cells that play a significant immunocompetent role such as cholangiocytes and kupfffer`s cells. It is therefore recommended that M. charantia can be used up to 1g/kg diet in order to improve the performance, visceral, and other lymphoid organs of hyperglycemic animals.

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