Scientific Reports in Life Sciences 6 (1): 1-16

DOI: https://doi.org/10.5281/zenodo.14945720

Antihyperglycemic effect of clove *(Syzyium aromaticum)* bud powder and hematological examination of rats

Syeda Warda Sakhawat*, Ali Asghar
National Institute of Food, Science and Technology, Faculty of Food, Science and Technology, University of Agriculture Faisalabad
**Email: syedawarda61@gmail.com*

Received: 25 October 2024 / Revised: 11 December 2024/ Accepted: 20 December 2024 / Published online: 02 March 2025.
How to cite: Sakhawat, S. W., Asghar, A. (2025). Antihyperglycemic effect of clove (*Syzyium aromaticum*) bud powder and hematological examination of rats, Scientific Reports in Life Sciences 6(1), 1-16. **DOI:** https://doi.org/10.5281/zenodo.14945720

Abstract

The modification in lifestyle and dietary patterns can cause chronic health disorders like hyperglycemia, hypercholesterolemia, cardiovascular disease, aging, mental health, and cancer. Hence, the focus of this research is to treat hyperglycemia with the use of clove in diet. An empirical approach is adopted to figure out the effectiveness of clove on serum chemistry and hematology of blood. 4 groups of diabetic mice (4 mice in each group) were supplemented clove (20mg/kg, 40mg/kg, and 60mg/kg body weight respectively) with diet for 21 days. The blood Glucose and hematology were measured on day 1 and day 21. It is found that the dietary supplementation with clove (Moisture content 9.9±1%, Crude Protein 6.69±1%, Crude Fat 16.64±0.1%, Ash 2.9±1 and NFE 42.13±1) significantly reduced the risk of hyperglycemia in mice and 40 mg/kg body weight of dose of clove is found effective to treat hyperglycemia. However, it is concluded that cloves are effective in reducing the risk of hyperglycemia.

Keywords: Hyperglycemia, Hematology, Clove Bud

Introduction

Diabetes Mellitus (DM) is a metabolic issue that takes place similarly as an effect from claiming failure of the body should emit insulin, or to settle on utilization of those insulin responses produced, alternately each (Bastaki, 2005; Deshmukh et al, 2015; Zarch et al., 2020). Insulin response insufficiency might promote hyperglycemia and hyperlipidemia due to disturbances from claiming sugar, fat, and protein digestion system (Adefegha & Oboh, 2012; Oboh et al., 2015).

The blood cholesterol level is elevated in Hypercholesterolemia and the blood glucose level is elevated in Hyperglycemia. There are two types of diabetes (Type I and Type II) (Eisenbarth, 1986). Insulin is not produced in type I. whereas a minute amount of insulin is produced in type II in the human body (Rother, 2007). The complex mechanism is involved in the process of hyperglycemia. The chain reaction occurs in diabetes like auto-oxidative glycosylation, protein kinase-C (product of glycation), and polyol cascade. Moreover, oxidative stress is increased due to activated oxygen species production (superoxide, hydroxyl radical, hydrogen peroxide) in diabetes (Aronson & Rayfield, 2002; de Carvalho Vidigal et al., 2012). Therefore, the human body has its defense system to neutralize free radicals. And body loses its resistance against free radicals scavenging activity in diabetes (Jellinger, 2007). Thus, activities of catalase (CAT) and superoxide dismutase (SOD) have been suppressed in diabetes leading to tissue damage (Ighodaro & Akinloye, 2018). However, the epidemiological investigations focus on dietary modification for diet-related disparities like hyperglycemia, hypercholesterolemia, and cancer (Lajolo, 2002). Spices or herbs are widely used as pharmaceutical and curative agents (Aruoma, 2006). Clove (*Syzygium aromaticum*) is used for enhancing aroma, seasoning, and for pharmaceutical purposes (Cortés-Rojas et al., 2014; Hussain et al., 2017; Silva et al., 2024). Phytochemicals that are available in clove assume a critical part in the upkeep of human well-being and in addition for sickness counteractive action (Dave & Ghaly, 2011; Hussain et al., 2017; Silva et al., 2024; Ullah et al., 2023). Indeed, even in small amounts, clove oil is used in food preservation. Phenolic compounds that are present in clove oil help in protein denaturation. The World Health Organization (WHO) Expert Committee on Food-added Substances declares that 2.5 mg/kg body weight is the day-by-day human admission of clove and the fatal oral dose is 3.75 g/kg body weight (Fischer, Von Unruh, & Dengler, 1990). Cloves (*Syzygium aromaticum*) additionally have many flavonoids, for example, kaempferol and rhamnetin that demonstrate solid mitigating and cell reinforcement properties (Huang et al., 2010). Clove powder displays cancer-prevention properties (Abadi et al., 2022). High cancer prevention agent focuses are available in flavors that hinder the oxidation of Low-density lipoprotein. Protein helps to tie cholesterol in the blood. Numerous cancer-preventing agents are available in cloves, vegetables, fruits, and herbs (Adefegha et al.,2018).

Material and methods

Proximate Composition Analysis of Clove

The Clove Buds were air-dried and ground into fine powder for the proximate analysis (Ash, moisture, crude lipid, protein, and fiber) was applied. The ash content was measured by using muffle furnace ash content**.** Ash in each dry sample was determined by direct incineration in a Muffle Furnace (MF-1/02, PCSIR, Pakistan) at 550-600˚C after charring, till it turned into grayish-white residue (International, 2000) Method No. 942.05. The moisture content of clove bud was determined by drying the sample in Air Forced Draft Oven (Model: DO-1-30/02, PCSIR, Pakistan) at 105 ± 5˚C till constant weight according to (International, 2000) method No. 934.01.

Crude Fat was determined using hexane as a solvent in the Soxtec System (Model: H-2 1045 Extraction Unit, Hoganas, Sweden) following the protocol of (International, 2000) Method No. 920.39. The concentration of protein in clove bud was determined using Kjeltech Apparatus (Model: D-40599, Behr Labor Technik, GMbh-Germany) according to the described procedure in (International, 2000) Method No. 984.13. The clove powder was digested with COC and H_2SO_4 through a digestion mixture (K_2SO_4:$FeSO_4$:$CuSO_4$ as100:5:10) until the color turned into transparent greenish. Then the digested samples were diluted in 250ml in a volumetric flask. Later on, the solution of 10ml NaOH and 10ml diluted samples was prepared in a distillation apparatus. Besides this, ammonium borate was prepared in separate beakers by adding liberated ammonia 4% boric acid solution and methyl (as the indicator). Then the ammonium borate was used for nitrogen determination in a sample. Finally, the percentage of nitrogen in samples was estimated by titrating the distillate against 0.1N H2SO4 solution, and then crude protein content was calculated by multiplying nitrogen percent (N %) with factor (6.25).

$$\text{N (\%)} = \frac{\text{Vol. of 0.1 N H2SO4} \times 0.0014 \times \text{Vol. of dilution (250ml)}}{\text{vol. of distilation taken} \times \text{Weight of smple}} \times 100$$

$$\text{Crude Protein (\%)} = \text{N (\%)} \times 6.25$$

The crude fiber in a fat-free sample will be estimated by digesting firstly with 1.25% H2SO4 for 30 min and then with 1.25% NaOH solution through Labcoco Fibertech (Labconco Corporation Kansas, USA) as described in (Horwitz and Latimer, 2000) Method No. 978.10. After that sample was filtered and washed with distilled water. The residue was weighed and placed in a muffle

furnace at a temperature of 550-650o C, till it turned into white or grey ash. Finally, the crude fiber percentage was estimated according to the following expression.

$$\text{Crude fiber (\%)} = \frac{\text{Weight loss on ignition (g)}}{\text{weight of sample (g)}} \times 100$$

Nitrogen-free extract in the clove bud sample was figured by using the given articulation.

NFE = 100- (%dry matter + % protein + %Ash + % Fat + % fiber)

Preparation of functional clove bread

Clove bread was prepared with some modifications in the recipe with different amounts of clove bud powder. A total of 4 bread samples were prepared. The ingredient of 1st sample of bread was normal and labeled as T_0. On the contrary, the rest three samples contain different amounts of clove (20 mg, 40 mg, and 60 mg respectively) along with other ingredients (Table 1). Finally, the quality and worthiness of clove bread were assessed for tangible parameters with a hedonic scale (Meilgaard et al., 1999).

Table 1. Treatment Plan for Preparation of Clove Bread

Sample no.	Clove bread
T_0	Control
T_1	20 mg
T_2	40 mg
T_3	60 mg

Application of treatments

12 rats were kept in a well-ventilated place at constant temperature with 12:00 hours of dark and light cycle and a planned diet was given to them. The rats were then divided into four groups after acclimatization (Table 2). Firstly, the rats were infected with under-investigated disease by providing a diet containing cholesterol and sucrose to raise their glucose and cholesterol levels. Once they got infected, they were fed a diet containing clove bud powder according to the treatment schedule. D_0 (rat group) was fed with a routine diet. Whereas, D_1, D_2, and D_3 (rat groups) were fed according to treatment schedule (20 mg, 40 mg, and 60 mg respectively). Finally, the overnight fasted rats were examined for blood glucose and hematology at Rifah Laborites Faisalabad.

Table 2. Distinctive Gatherings led to the Viability Trials

Treatments	Specimen Groups	Functional diet (feed dietary clove bud powder mg/kg)
T_0	D_0	0
T_1	D_1	20
T_2	D_2	40
T_3	D_3	60

Statistical Analysis

The digital database was designed in Microsoft Excel and the mean was calculated for the reading of day 1st and day 21st. Then this data set was imported into Statistics 10 software for analysis of variance (AOV). A complete Randomized Design (CRD) analysis was deployed to find the validity and variability for sensory evaluation. And factorial design analysis was deployed to find the validity; reliability and variability of the treatment plan (Montgomery, 2017).

Results

Proximate analysis (composition of clove)

The general nutritional characteristics of clove are measured to precede this research in a truly scientific manner. The proximate chemical composition of clove like moisture content, crude protein, crude fiber, Ash content, and nitrogen-free extract (NFE) is measured in the laboratory through different techniques with the help of different lab equipment. A detail description of the techniques is available in (Aruoma, 2006). However, the moisture content of the clove was measured through air forced draft oven. Then the descriptive analysis was applied to calculate the mean value and standard deviation of 3 samples. The calculated mean value of moisture content is 9.9±1. The crude protein was measured through the Kjeltech apparatus in the laboratory. The mean value of protein content in clove is 6.69±1. The mean of crude fat is 16.64±0.1. The ash content was measured through muffle furnace ash content. The calculated mean value of ash content in clove is 2.9±1. The NFE was calculated through the above-mentioned equation and the mean value of NFE is 42.13±1 (Table 3). Anyhow, the results of the proximate chemical composition of clove are found similar to (Sulieman, El-Boshra, & El-Khalifa, 2007). According to this study, the proximate chemical composition of clove was moisture (10+-0.005%), fiber (20+-0.1%), ash (5.2+-0.01%), protein (1.2+-0.02%), fat (12.1+-0.45%) and carbohydrates (51.5+-0.01%).

Table 3. Proximate Analysis of Clove

Moisture	Crude protein	Crude fat	Ash	NFE
9.9±1	6.69±1	16.64±0.1	2.9±1	42.13±1

Sensory evaluation of clove bread

The evaluation is done in two phases. Firstly, the product was given to taste and secondly, feedback was taken through a closed-ended questionnaire. For this purpose, four bread samples were prepared in the bakery of the University of Agriculture Faisalabad. The main ingredients are discussed in the previous section. However, the prepared bread samples were given to the student and faculty members (total participants 50) of different institutes like Independent Medical College Faisalabad, GC University Faisalabad, and the University of Agriculture for feedback for acceptance or rejection of the product. For the feedback, a questionnaire was designed consisting of two sections. The first section includes parameters *i.e.* color, softness, flavor, taste, texture, and overall acceptability, and sample numbers *i.e.* T_0, T_1, T_2, and T_3. The second section consists of a hedonic scale to express the feeling of acceptability or rejection. The results of each variable of this analysis are discussed in detail in the following section.

Color

T_0 gets the highest score (6.884±0.1543) on the hedonic scale and T_1 6.1765±0.1543 gets 2nd highest score. However, the T_2 is found more favorite than the rest of the samples. The mean value of T_2 is 6.8039±0.1543. On the contrary, the T_3 shows entirely different results. The participants dislike it very much. The mean value of T_3 is 3.617±0.1607. Overall, T_2 is found most favorite product in the rest of the samples (Table 4).

Softness

T_0 gets the highest score (6.9412±0.1497) on the hedonic scale and T_1 6.451±0.1497 gets 2nd highest score. However, the T_2 is found more favorite than the rest of the samples. The mean value of T_2 is 6.8824±0.1497. On the contrary, the T_3 shows entirely different results. The participants dislike it very much. The mean value of T_3 is 4.5957±0.156. Overall, T_2 is found most favorite product in the rest of the samples (Table 4).

Flavor

T_0 gets the 2nd highest score (6.82354±0.133) on the hedonic scale and T_1 (6.1765±0.1543) gets the 3rd highest score. However, the T_2 is found more favorite than the rest of the samples. The mean value of T_2 is 6.9608±0.133 and gets the highest score. On the contrary, the T_3 shows entirely different results. The participants dislike it very much. The mean value of T_3 is 2.8298±0.1385. Overall, T_2 is found most favorite product in the rest of the samples (Table 4).

Taste

T_0 gets the highest score (7.1176±0.1145) on the hedonic scale and T_1 (6.2549±0.1145) gets 3rd highest score. However, the T_2 is found more favorite than the rest of the samples. The mean value of T_2 is 6.6.7255±0.1145 and gets 2nd highest score. On the contrary, the T_3 shows entirely different results. The participants dislike it very much. The mean value of T_3 is 3.1489±0.0.1193. Overall, T_2 is found most favorite product in the rest of the samples (Table 4).

Texture

T_0 gets the highest score (6.8824±0.1386) on the hedonic scale and T_1 6.2745±0.1386 gets 3rd highest score. But the T_2 is found more favorite than the rest of the samples. The mean value of T_2 is 6.8039±0.1386 and gets 2nd highest score. On the contrary, the T_3 shows entirely different results. The participants dislike it very much. The mean value of T_3 is 3.6596±0.1444. Overall, T_2 is found most favorite product in the rest of the samples (Table 4).

Overall acceptance

T_0 gets the highest score (6.8235±0.1411) on the hedonic scale and T_1 6.2549±0.1411 gets 3rd highest score. But the T_2 is found more favorite than the rest of the samples. The mean value of T_2 is 6.6471±0.1411. On the contrary, the T_3 shows entirely different results. The participants dislike it very much. The mean value of T_3 is 3.3191±0.147. Overall, T_2 is Found most favorite product than the rest of all samples (Table 4).

Table 4. Mean ± standard deviation for sensory evaluation for clove bread

Parameters	**Treatment**			
	T_0	T_1	T_2	T_3
Color	6.1765±0.5179[a]	6.1765±0.5179[b]	6.8039±0.5664[a]	3.6275±1.9075[c]
Softness	6.451±0.7018[a]	6.451±0.7018[b]	6.8824±0.6526[a]	4.4706±1.8039[c]
Flavor	6.5098±0.7582[a]	6.5098±0.7582[b]	6.9608±0.7736[a]	2.8627±1.3419[c]
Taste	6.2549±0.4401[a]	6.2549±0.4401[b]	6.7255±0.5321a	3.0588±1.3178[c]
Texture	6.2745±0.5321[b]	6.2745±0.5321[b]	6.8039±0.7217[a]	3.7.59±1.6649[c]
Overall Acceptability	6.2549±0.5232[b]	6.2549±0.5232[b]	6.6471±0.4826[a]	3.2353±1.7273[c]

T_0 -acts as control
T_1 -20mg/Kg clove bud powder
T_2 -40mg/Kg clove bud powder
T_3- 60mg/kg clove bud powder

Vivo studies

The therapeutic and nutraceutical potential of clove powder can be determined by efficacy studies in treating hyperglycemia. Purposely, an animal study was performed using rats due to little health concern, controlled environmental conditions, and appropriate supervision as compared to human subjects. Firstly, the rats were infected with under-investigated disease by providing a high sucrose diet to raise their glucose level. Once they get infected, a Specific diet was fed to respective groups to aggravate blood glucose levels for a particular time. At initiation, rats were also collected to get baseline values and at the end of the study, the blood sample was also collected to check the effect of clove. Furthermore, variation in hematological characteristics was also observed and obtained results were analyzed statistically to check the level of significance.

Hematological analysis

Hemoglobin

The measured mean values of D_0, D_1, D_2 and D_3 are 12.6±1, 13.3±1, 12.4±1 and 12.6±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 12.5±1, 13.9±1, 13.6± and 12.8±1 on the day1 and day21respectively. Thus, a significant increasing trend is found between the results of day 1 and day 21. Overall mean values range from 12.725±0.89435 g/dl and 13.2±1 g/dl respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of hemoglobin in the blood. The referenced value is 15.4±1.05 g/dl (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating hemoglobin in the blood (Table 5). However, (Wolford et al., 1986) designed a reference range database for serum chemistry and hematology values in laboratory animals. The reference database values were estimated by the study of more than 3000 animals (species included mouse, rat, hamster, rabbit, beagle dog, and cynomolgus monkey). The database illustrates the mean, standard deviation, and 10^{th} and 90^{th} percentiles for each parameter. The database of mouse < 1 year is selected because the age of the mouse used in our research is < 1 year. The serum chemistry and hematology of samples are matched with this database in the following section.

Hematocrit

The measured mean values of D_0, D_1, D_2 and D_3 are 33.7±1, 36.5±1, 32.9±1 and 30.9±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 30.9±1, 36.8±1, 36.5± and 32.6±1 on the day 1 and day21respectively. Thus, a significant increasing trend is found between the results of day 1 and day 21. Overall mean values range from 33.5±1% and 33.95±1% respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of hematocrit in blood. The referenced value is 42.6±3.22% (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating hematocrit in the blood (Table 5).

Total RBC count

The measured mean values of D_0, D_1, D_2 and D_3 are 5.6±1, 5.78±1, 5.64±1 and 5.6±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 5.78±1, 6.24±1, 6.34±1 and 5.75±1 on the day 1 and day21respectively. Thus, a significant increasing trend is found between the results of day 1 and day 21. The mean values range from 5.655±1 M/uL and 6.0275±1M/uL respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of total RBC count in blood. The referenced value is 9.11±0.697M/(Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating total RBC count in blood (Table 5).

MCV

The measured mean values of D_0, D_1, D_2 and D_3 are 59.4±1, 62±1, 58.3±1 and 57.1±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 53.4±1, 58.9±1, 55.1±1 and 54.5±1 on the day 1 and day21respectively. Thus, a significant decreasing trend is found between the results of day 1 and day 21. Overall mean values range from 59.2±1 and 55.475±1 respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of MCV in blood. The referenced value is 46.8±1.82 (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating MCV in the blood (Table 5).

MCH

The measured mean values of D_0, D_1, D_2 and D_3 are 22.2±1, 23.1±1, 22±1 and 22.9±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 21.6±1, 22.3±1, 21.2±1 and 21.4±1 on the day 1 and day21respectively. Thus, a significant decreasing trend is found between the results of day 1 and

day 21. Overall mean values range from 22.55±1 PG and 21.625±1 PG respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of MCH in blood. The referenced value is 17.0±0.79 PG (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating MCH in the blood (Table 5).

MCHC

The measured mean values of D_0, D_1, D_2 and D_3 are 37.5±1, 36.6±1, 37.7±1 and 38.4±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 40.4±1, 37.9±1, 38.5±1 and 41±1 on the day 1 and day21respectively. Thus, a significant increasing trend is found between the results of day 1 and day 21. Overall mean values range from 37.55±1 G/dL and 39.45±1G/dL respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of MCHC in blood. The referenced value is 36.3±1.26G/dL(Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating MCHC in the blood (Table 5).

Total WBC count

The measured mean values of D_0, D_1, D_2 and D_3 are 5±1, 6.2±1, 10.5±1 and 7.1±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 9.1±1, 10.2±1, 13±1 and 9.8±1 on the day 1 and day21respectively. Thus, a significant increasing trend is found between the results of day 1 and day 21. Overall mean values range from 7.2±1 K/uL and 10.525±1 K/uL respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of total WBC count in the blood. The referenced value is 8.0±3.2 K/uL(Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating total WBC count in blood (Table 5).

Neutrophils

The measured mean values of D_0, D_1, D_2 and D_3 are 20±1, 29±1, 28±1 and 28±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 30±1, 31±1, 37±1 and 41±1 on the day 1 and day21respectively. Thus, a significantly increasing trend is found between the results of day 1 and day 21. Overall mean values range from 26.25±1% and 34.75±1% respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of neutrophils in the blood. The referenced value is 19±8.9% (Wolford et al., 1986). Thus, it is

concluded that the dose of 40mg/Kg body weight is found good for treating neutrophils in blood (Table 5).

Lymphocytes

The measured mean values of D_0, D_1, D_2 and D_3 are 75±1, 67±1, 67±1 and 66±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 66±1, 65±1, ±1 and 56±1 on the day 1 and day21respectively. Thus, a significantly decreasing trend is found between the results of day 1 and day 21. Overall mean values range from 68.75±1% and 61.25±1% respectively. While comparing these results to the reference database, significant improvement is found to maintain the concentration of Lymphocytes in blood. The referenced value is 77±11.07% (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating Lymphocytes in the blood (Table 5).

Monocytes

The measured mean values of D_0, D_1, D_2 and D_3 are 4±1, 2±1, 3±1 and 3±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 1±1, 2±1, 4±1 and 1±1 on the day 1 and day21respectively. Thus, a significantly decreasing trend is found between the results of day 1 and day 21. Overall mean values range from 3±1% and 2±1% respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of monocytes in the blood. The referenced value is 2±1.9% (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating monocytes in the blood (Table 5).

Eosinophil

The measured mean values of D_0, D_1, D_2 and D_3 are 1±1, 0±1, 2±1 and 3±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 3±1, 3±1, 1±1 and 2±1 on the day 1 and day21respectively. Thus, a significantly increasing trend is found between the results of day 1 and day 21. Overall mean values range from 1.5±0.75% and 2.25±1% respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of eosinophil in blood. The referenced value is 1±1.0% (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating eosinophil in the blood (Table 5).

Platelets count

The measured mean values of D_0, D_1, D_2 and D_3 are 1051±1, 855±1, 967±1 and 934±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 775±1, 722±1, 861± and 754±1 on the day 1 and

day21respectively. Thus, a significant decreasing trend is found between the results of day 1 and day 21. Overall mean values range from 951.75±1 K/Ul and 778±1K/Ul respectively. While comparing these results to the reference database, significant improvement is found in maintaining the concentration of platelets in the blood. The referenced value is 1199±199.9 K/Ul (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good for treating platelet count in blood (Table 5).

Table 5. Mean ± SD for the effect of clove on hematological Investigation

Hematological Examination					
	Duration	**Group**			
		D_0	D_1	D_2	D_3
Hemoglobin g/dl	**1 day**	12.6±0.5774	13.3±1	12.4±1	12.6±1
	21 day	12.5±1	13.9±1	13.6±1	12.8±1
Hematocrit %	**1 day**	33.7±1	36.5±1	32.9±1	30.9±1
	21 day	30.9±1	36.8±1	35.5±1	32.6±1
Total RBC count M/ul	**1 day**	5.6±1	5.78±1	5.64±1	5.6±1
	21 day	5.78±1	6.24±1	6.34±1	5.75±1
M.C.V	**1 day**	59.4±1	62±1	58.3±1	57.1±1
	21 day	53.4±1	58.9±1	55.1±1	54.5±1
M.C.H PG	**1 day**	22.2±1	23.1±1	22±1	22.9±1
	21 day	21.6±1	22.3±1	21.2±1	21.4±1
M.C.H.C G/dl	**1 day**	37.5±1	36.6±1	37.7±1	38.4±1
	21 day	40.4±1	37.9±1	38.5±1	41±1
Total WBC count K/ul	**1 day**	5±1	6.2±1	10.5±1	7.1±1
	21 day	9.1±1	10.2±1	13±1	9.8±1
Neutrophils %	**1 day**	20±1	29±1	28±1	28±1
	21 day	30±1	31±1	37±1	41±1
Lymphocytes %	**1 day**	75±1	67±1	67±1	66±1
	21 day	66±1	65±1	58±1	56±1
Monocytes %	**1 day**	4±1	2±1	3±1	3±1
	21 day	1±1	2±1	4±1	1±1
Eosinophil %	**1 day**	1±1	0±1	2±1	3±1
	21 day	3±1	3±1	1±1	2±1
Basophils %	**1 day**	0±0	0±0	0±0	0±0
	21 day	0±0	0±0	0±0	0±0
Platelets count K/Ul	**1 day**	1051±1	855±1	967±1	934±1
	21 day	775±1	722±1	861±1	754±1

Serum chemistry

Blood glucose

The measured mean values of D_0, D_1, D_2 and D_3 are 136±1, 175±1, 189±1 and 176±1. Whilst, the mean values of D_0, D_1, D_2 and D_3 are 137±1, 125±1, 140±1 and 130±1 on the day 1 and day21 respectively. Thus, a significantly decreasing trend is found between the results of day 1 and day 21. Overall mean values range from 169±10 mg/dl and 133±7.75 mg/dl respectively. While comparing these results to the reference database, it is found significant improvement in Blood Glucose maintenance in blood. The referenced value is 146±50.1 mg/dl (Wolford et al., 1986). Thus, it is concluded that the dose of 40mg/Kg body weight is found good to treat Blood Glucose in blood (Table 6). The results are quite similar to the results of (Adefegha & Oboh, 2012). The study revealed a significant decrease in the blood glucose level in diabetic rats. (Dziri et al., 2012) studied the effect of clove oil on diabetic rats. Clove oil showed effective results and revealed that modulates physiology responses in streptozotocin. The study of vivo organs revealed the effect of dietary cloves in chronic hyperglycemia and tissue protection. The doses of cloves 100mg total eugenol + eugenol acetate per kg body weight/day were given to diabetic male Sprague Dawley rats. During fasting of blood glucose levels, different organ tissues and their physical and biochemical properties were investigated.

Table 6. Mean ± SD for Blood glucose mg/dl in rats

Duration	Group			
	D_0	D_1	D_2	D_3
1 day	136±10	175±10	189±10	176±10
21 day	137±1	125±10	140±10	130±10

Conclusion

Hyperglycemia is a complex disorder and a state of high sugar levels in the blood (Sharma et al., 2010). It occurs due to a lack of essential nutrients, and high amounts of fatty or sweet foods and is responsible for some other disorders like dysfunction of cardio muscles, bedwetting, weight loss, and loss of essential vitamins and minerals (Annapurna, Mahalakshmi, & Krishna, 2001). Anyhow, physical therapies and dietary interventions (functional and nutraceutical foods) are being recommended by health experts to treat different health disorders. Hence, the focus of this research is to treat hyperglycemia and hyperlipidemia with the use of clove in diet. An empirical approach is adopted to figure out the effectiveness of clove on serum chemistry (Glucose,

Cholesterol, and Triglycerides) and hematology (Hemoglobin, Hematocrit, Red Blood Cells, White Blood Cells, Platelets, MCV, MCH, MCHC, Neutrophils, Eosinophils, Monocytes and Lymphocytes) of blood. It is found that the dietary supplementation with clove (Moisture content 9.9±1%, Crude Protein 6.69±1%, Crude Fat 16.64±0.1%, Ash 2.9±1 and NFE 42.13±1) significantly reduced the risk of hyperglycemia in mice. The results revealed a significant improvement in hematology (Hemoglobin 12.725±0.89435 g/dl to 13.2±1 g/dl, Hematocrit 33.5±1 % to 33.95±1 %, Red Blood Cells 5.655±1 M/uL to 6.0275±1 M/uL, White Blood Cells 7.2±1 K/uL to 10.525±1 K/uL, Platelets 951.75±1 K/Ul to 778±1 K/Ul, MCV 59.2±1 to 55.475±1, MCH 22.55±1 PG to 21.625±1 PG, MCHC 37.55±1 G/dl to 39.45±1G/dl, Neutrophils 26.25±1% to 34.75±1%, Eosinophils 1.5±0.75% to 2.25±1%, Monocytes 3±1% to 2±1% and Lymphocytes 68.75±1% to 61.25±1%) and blood chemistry (Glucose 169±10 to 133±7.75 mg/dl). Furthermore, a 40 mg/kg body weight dose of clove is found effective in treating hyperglycemia and hyperlipidemia. A bulk of published literature is available that suggests that clove has the potential effects to reduce the risk of hyperglycemia hyperlipidemia and some other disorders.

References

Abadi, A. V. M., Karimi, E., Oskoueian, E., Mohammad, G. R. K. S., & Shafaei, N. (2022). Chemical investigation and screening of anti-cancer potential of *Syzygium aromaticum* L. bud (clove) essential oil nanoemulsion. 3 Biotech, 12(2), 49.

Adefegha, S., Oboh, G., & Olabiy, A. (2018). Nutritional, antioxidant and inhibitory properties of cocoa powder enriched wheat-plantain biscuits on key enzymes linked to type 2 diabetes. International Food Research Journal, 25(2).

Adefegha, S. A., & Oboh, G. (2012). In vitro inhibition activity of polyphenol-rich extracts from *Syzygium aromaticum* (L.) Merr. & Perry (Clove) buds against carbohydrate hydrolyzing enzymes linked to type 2 diabetes and Fe2+-induced lipid peroxidation in rat pancreas. Asian Pacific Journal of Tropical Biomedicine, 2(10), 774-781.

Annapurna, A., Mahalakshmi, D. K., & Krishna, K. M. (2001). Antidiabetic activity of a poly herbal preparation (tincture of panchparna) in normal and diabetic rats.

Aronson, D., & Rayfield, E. J. (2002). How hyperglycemia promotes atherosclerosis: molecular mechanisms. Cardiovascular diabetology, 1, 1-10.

Aruoma, O. I. (2006). The impact of food regulation on the food supply chain. Toxicology, 221(1), 119-127.

Bastaki, S. (2005). Diabetes mellitus and its treatment. International journal of Diabetes and Metabolism, 13(3), 111-134.

Cortés-Rojas, D. F., de Souza, C. R. F., & Oliveira, W. P. (2014). Clove (*Syzygium aromaticum*): a precious spice. Asian Pacific Journal of Tropical Biomedicine, 4(2), 90-96.

Dave, D., & Ghaly, A. E. (2011). Meat spoilage mechanisms and preservation techniques: a critical review. American Journal of Agricultural and Biological Sciences, 6(4), 486-510.

De Carvalho Vidigal, F., Cocate, P. G., Pereira, L. G., & Alfenas, C. G. (2012). The role of hyperglycemia in the induction of oxidative stress and inflammatory process. Nutricion hospitalaria, 27(5), 1391-1398.

Deshmukh, C. D., Jain, A., & Nahata, B. (2015). Diabetes mellitus: a review. International Journal of Pure & Applied Bioscience (IJPAB), 3(3), 224-230.

Dziri, S., Hassen, I., Fatnassi, S., Mrabet, Y., Casabianca, H., Hanchi, B., & Hosni, K. (2012). Phenolic constituents, antioxidant and antimicrobial activities of rosy garlic (Allium roseum var. odoratissimum). Journal of functional foods, 4(2), 423-432.

Eisenbarth, G. S. (1986). Type I diabetes mellitus. New England journal of medicine, 314(21), 1360-1368.

Fischer, I., Von Unruh, G., & Dengler, H. (1990). The metabolism of eugenol in man. Xenobiotica, 20(2), 209-222.

Huang, B., Ban, X., He, J., Zeng, H., Zhang, P., & Wang, Y. (2010). Hepatoprotective and antioxidant effects of the methanolic extract from Halenia elliptica. Journal of ethnopharmacology, 131(2), 276-281.

Hussain, S., Rahman, R., Mushtaq, A., & Zerey-Belaskri, A. E. (2017). Clove: A review of a precious species with multiple uses. International Journal of Chemical and Biochemical Sciences, 11, 129-133.

Ighodaro, O., & Akinloye, O. (2018). First line defence antioxidants-superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX): Their fundamental role in the entire antioxidant defence grid. Alexandria journal of medicine, 54(4), 287-293.

International, A. (2000). Official methods of analysis of AOAC International (Vol. 17). AOAC international.

Jellinger, P. S. (2007). Metabolic consequences of hyperglycemia and insulin resistance. Clinical cornerstone, 8, S30-S42.

Lajolo, F. M. (2002). Functional foods: latin american perspectives. British journal of nutrition, 88(S2), S145-S150.

Meilgaard, M. C., Carr, B. T., & Civille, G. V. (1999). Sensory evaluation techniques. CRC press.

Montgomery, D. C. (2017). Design and analysis of experiments. John wiley & sons.

Oboh, G., Agunloye, O. M., Adefegha, S. A., Akinyemi, A. J., & Ademiluyi, A. O. (2015). Caffeic and chlorogenic acids inhibit key enzymes linked to type 2 diabetes (in vitro): a comparative study. Journal of basic and clinical physiology and pharmacology, 26(2), 165-170.

Rother, K. I. (2007). Diabetes treatment—bridging the divide. The New England journal of medicine, 356(15), 1499.

Sharma, V. K., Kumar, S., Patel, H. J., & Hugar, S. (2010). Hypoglycemic activity of Ficus glomerata in alloxan induced diabetic rats. International Journal of Pharmaceutical Sciences Review and Research, 1(2), 18-22.

Silva, M. V., de Lima, A. d. C. A., Silva, M. G., Caetano, V. F., de Andrade, M. F., da Silva, R. G. C., de Moraes, L. E. P. T., de Lima Silva, I. D., & Vinhas, G. M. (2024). Clove essential oil and eugenol: A review of their significance and uses. Food Bioscience, 105112.

Sulieman, A. M. E., El-Boshra, I. M., & El-Khalifa, E. (2007). Nutritive value of clove (*Syzygium aromaticum*) and detection of antimicrobial effect of its bud oil.

Ullah, M. A., Hassan, A., & Hamza, A. (2023). Role of Clove in Human Medical History. SAR Journal of Anatomy and Physiology, 4(2), 10-19.

Wolford, S., Schroer, R., Gohs, F., Gallo, P., Brodeck, M., Falk, H., & Ruhren, R. (1986). Reference range data base for serum chemistry and hematology values in laboratory animals. Journal of Toxicology and Environmental Health, Part A Current Issues, 18(2), 161-188.

Zarch, S. M. A., Tezerjani, M. D., Talebi, M., & Mehrjardi, M. Y. V. (2020). Molecular biomarkers in diabetes mellitus (DM). Medical journal of the Islamic republic of Iran, 34, 28.