

RESEARCH ARTICLE

Extraction, Characterization and Therapeutic Evaluation of Seeds of *Phaseolus vulgaris* L. for Inhibition of Carbohydrate Uptake

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ABSTRACT

Phaseolamin-rich beans, also known as -amylase inhibitor 1 (AI) bean. AI has shown promise in treating diabetes and obesity in human studies. Since enzymes speed up chemical reactions, thus they are needed for most biological processes. Humans have used catalysts for centuries. Chemical catalysis was a heavy, often-used method. The method lacks sensitivity, and catalysis requires high temperature and pressure. Enzymes may function under more benign settings than chemical catalysts. Enzymes speed up chemical processes more than chemical catalysts due to their specificity. Enzymes are used in practically every industry today. Enzymes have always been crucial. Enzymes have also been used to treat digestive diseases, coagulate milk for cheese, and process starch for drinks. Amylase is becoming increasingly popular because it may break down starch in multiple ways. Amylase reactions then cover amylases and other enzymatic reactions covered in this article as a catalyst. Amylases, a kind of hydrolase enzyme, are widely used. These enzymes randomly disrupt the glycosidic connections within starch molecules, releasing dextrin and oligosaccharides. Amylase is the most versatile type of amylase. Enzymes are replacing traditional chemical catalysts as consumers become more ecologically conscious

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INTRODUCTION

All strains of *Phaseolus vulgaris* generate the same kind of alpha-AI type 1 enzyme; nevertheless, the fundamental makeup of this enzyme may vary greatly from strain to strain. On the other hand, these enzymes all have the same impact on animal amylases, which prevents them from functioning properly. In the year 1945 this enzyme was identified. However, till 1975 it was not named specifically. Thus in 1975 it was nomenclature as "phaseolamin." Since then, researchers have been looking into the effectiveness of phaseolamin as a starch blocker, and pure extracts of the compound have been used in anti-hyperglycemic and anti-obesity supplements for food supplement purposes. However, the results did not live up to expectations, most likely as a result of the inadequate inhibitory action on human alpha-amylase. Because of the advancements in protein extraction, purification, and standardization, it is now possible to create bean plant extracts that have specific effects on glucose metabolism that are more powerful and have a greater impact. It is important to highlight that *P. vulgaris* is not alone among plants in having alpha-amylase inhibitors.

Other plants also have this property. Additionally, they may be found on a variety of cereal plants. However, there have been no reports of major adverse effects from the alpha-AIs in it, although cereal-derived isoforms have been linked to dermatitis and asthma.^{1,2}

Types of Amylase Enzyme

α -Amylase

The α -1, 4 glycosidic connections that are included inside the starch molecule have to be dissolved by the amylase enzyme before the molecule can be digested. As a consequence of this process, sugars such as glucose and maltose are created. Because it is a calcium metalloenzyme, its activity depends on a metal cofactor's presence. To restate the point, it is unable to perform its role in the absence of metal.³⁻⁵

β -Amylase

The exo-hydrolase enzyme known as β -amylase is responsible for the liberation of a maltose unit from the non-reducing end of a polysaccharide chain. The activity that we are interested in is catalyzed by the polysaccharide that comes first in the chain.

In order to do this, α -1, 4-glucan connections must be cleaved. Because of their branching connections, branched polysaccharides like glycogen and amylopectin are resistant to hydrolysis. Examples of these include starches and sugars. This suggests that some dextrin units will still be present after the hydrolysis process has been completed.⁵

γ -Amylase

In contrast to other types of amylase, γ -amylase has the unique ability to break the glycosidic bonds of amylose and amylopectin at both the non-reducing end (1-4) and the reducing end (1-6).⁴ The glycosylation of amylose and amylopectin shows glycosidic linkages. Causes glucose. amylase performs at its highest level of efficiency in environments with a pH ranging from 3 to 2.

MATERIALS AND METHODS

Collection of Phytochemical Material

The *P. vulgaris* was acquired legally from reputable firms. That was further confirmed in the appropriate amount of time.⁶⁻⁸

Pharmacognostic Study

Various aspects were looked into for *P. vulgaris* from several different perspectives, including morphology, microscopy, chemistry, and physics.¹⁰

Seeds and Preparation of Crude Bean Extract

After soaking for 5 hours and then boiling for 15 minutes in fresh water, the ground seeds were used (for the deactivation of Phytohaemoglutin). The aqueous extraction process uses dried aqueous extract regardless of screening with a cold press or hot water. After that, the material goes through a screening process, and then it is dried under a vacuum. Calculation of the extractive value will occur once the extraction process was performed.¹¹⁻¹³

Pharmacological Screening

Estimating the potency of crude drug or its preparation was studied through enzyme inhibition activity.

Inhibition of Carbohydrate Uptake

Phaseolamin is a glycoprotein that is available in common beans. It is also known as amylase inhibitor 1 (AI) (*P. vulgaris* L.). This is due to the fact that it inhibits the action of certain amylases, which are essential for the digestion of starch in both insects and humans. Several human clinical trials have demonstrated that bean AI may have therapeutic value in the management of both obesity and diabetes. Enzymes, which are able to speed up various chemical reactions, are essential to almost every facet of living things due to their capacity.^{14,15} People have been relying on the catalysts that they have generated for a considerable time. Due to the frequency with which it was used, chemical catalysis was a laborious process to carry out. A significant shortcoming of the process is that it does not take sensitivity into account. Another problem is that catalysis has to take place at very high temperatures and intense pressures. The use of enzymes can avoid these problems. The use of enzymes, may be preferable to the use of chemical

catalysts in situations when the conditions are not as stringent. Because of their high level of specificity, enzymes are far more effective as catalysts than chemical catalysts. Enzymes are essential to the functioning of the whole modern economy in some form or another. In the past, enzymes have been used in treating gastrointestinal problems, coagulation of milk for the cheese production and the transformation of starch into a form that Although there are a number of different enzymes that are used, amylase is becoming more popular owing to the flexibility it has when it comes to breaking down starch. After this, it is proposed to proceed to investigate several amylases and the chemical reactions made possible by them in more depth. Since quite some time ago, amylases, a kind of hydrolase enzyme, have been put to a variety of beneficial uses. The enzymes randomly severed the glycosidic connections contained inside the starch molecules. This opens the door for the release of dextrin and oligosaccharides from the starch molecules. The amylase enzyme is the most useful kind of amylase because of its wide range of applications. As customers become more environmentally concerned, a growing number of firms are moving away from using chemical catalysts and toward using enzymes instead.¹⁷

Assay for α -amylase Inhibition

To evaluate whether or not α -amylase was being inhibited, the researchers kept track of the amount of sugar that was produced and expressed it as maltose equivalents. This allowed them to establish whether or not the enzyme was being stopped. It was possible to get a broad understanding of the enzyme's activity by counting the number of units of maltose that were liberated as a result of its inactivation. This was a viable method. In order to calculate the maltose equivalent, several adjustments were made to the dinitrosalicylic acid (DNS) method. During the experiment, one mL of FAF with a concentration ranging from 100 to 500 g/mL was mixed with amylase at a concentration of 1 unit per mL for 30 minutes. The next step was adding a starch solution with a weight-to-volume ratio of 1%, which brought the total volume up to 1 mL.¹⁸⁻²⁰ After waiting ten minutes at 37°C, another stirring was performed. To achieve this goal, 1 mL of DNS reagent was added to the mixture. Post a blank run to remove the amylase enzyme and the test solutions, the same amount of buffer was added to each solution (pH 6.9 at 20°C, 20 mM sodium phosphate buffer, 6.7 mM Sodium chloride). Using a wavelength of 540 nm, the absorbance was calculated. Based on the experiments above, it was possible to determine the quantity of sugar, which was presented in the form of maltose equivalent that is released throughout the process of starch digestion by using a typical graph. The acarbose was effective in fulfilling its role as a control drug. Following this step, the FAF was diluted with buffer to a concentration that ranged between 5 and 10 mg/mL. It was believed that decreases in the amount of α -amylase activity were a sign of the effectiveness of diabetes therapy.^{21,22}

In order to calculate this, the percentage of amylase inhibition was plugged into the following equation:

$$\% \text{reaction} = \frac{\text{test}}{\text{control}} \times 100$$

• **Animals**

The experiment started with 20 g male C57BL/6 mice. At Ce.S.A.L, the animals were put to experiment for a week after arriving. Each 26x41 cm cage contained 12 mice.²³

• **Induction of metabolic syndrome**

After 19 weeks of eating a high-fat diet, the animals developed metabolic syndrome. Minor changes were made to the previously disclosed model. 60% of HFD calories come from fat, 20% from protein, and 20% from carbs. Control mice were fed a combination of protein (24%), carbs (58%), and fat (18%) until 19 weeks old.²⁴

• **Extract Preparation**

This study employed a standardized seed dry extract. Both alpha-amylase inhibitor and phytohemagglutinin were present in this extract. Dry *P. vulgaris* extract was obtained from common kidney bean using water extraction and alcoholic precipitation (*P. vulgaris*). First, the beans were extracted using a citrate buffer, then they were settled in ethanol. The extract has been shown to have a-amylase inhibitor activity of 1400 U/mg and a phytohemagglutinin activity of 16 hemagglutination units/mg. Both actions are assessed per mg.²⁵⁻²⁷

• **Treatments**

Oral administration of folic acid 500 mg kg⁻¹ and acarbose 100 mg kg⁻¹ mixed with 1% carboxymethyl cellulose sodium salt was done at the animal facility between weeks 11 and 19 30 minutes before the start of the dark circadian phase. After reading, *P. vulgaris* and acarbose doses were chosen.²⁸

RESULT AND DISCUSSION

Pharmacognostic Study

Macroscopy of P. vulgaris L. Seed

The length, width, ratio of length to width, weight per 100 seeds, color, number of colors, primary/main color, secondary/ accent color, distribution of accent color, veining, shape, primary/secondary color, and coat pattern were all subjected to quantitative and qualitative analysis.

Microscopy of P. vulgaris L. Seed (Figure 1 and 2)

This photograph shows a transverse section of a mature kidney bean seed. When an ovary has reached maturity, the outer wall that is referred as pericarp. The layer that is located above pericarp is the exocarp. The layer located in the centre is referred to as the mesocarp, while the one located on the inside is referred to as the endocarp. The exocarp comprises the epidermis and a thin layer of cells known as the subepidermal layer, which is located directly below the epidermis. The endocarp develops as a result of the interaction between the pericarp and the inner epidermis. At this stage, there are few parenchymatous cells in the fruit wall that have not been removed yet. Because of their cell walls' thinness and their sizes fluctuate across various planes, parenchymatous cells do not stain very well. Even while there is still an inner epidermis,

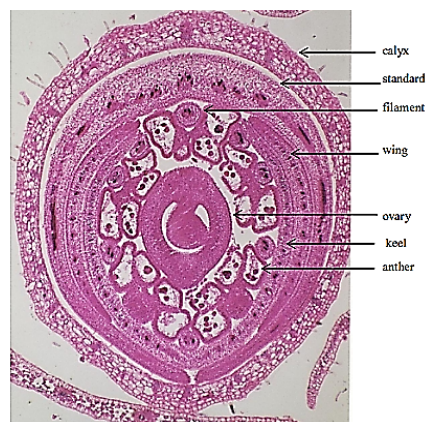


Figure 1: Section through the floral bud of the *P. vulgaris* L. plant (X 52).

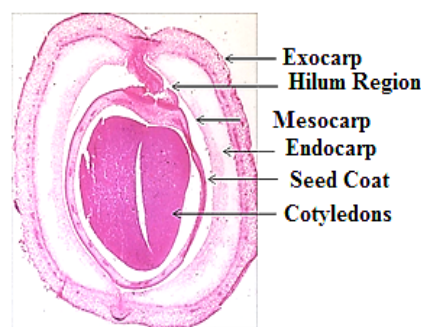


Figure 2: Cross-section of the ripe pod of the *P. vulgaris* L. plant, illustrating the structure of the fruit and the seed. (X 12).

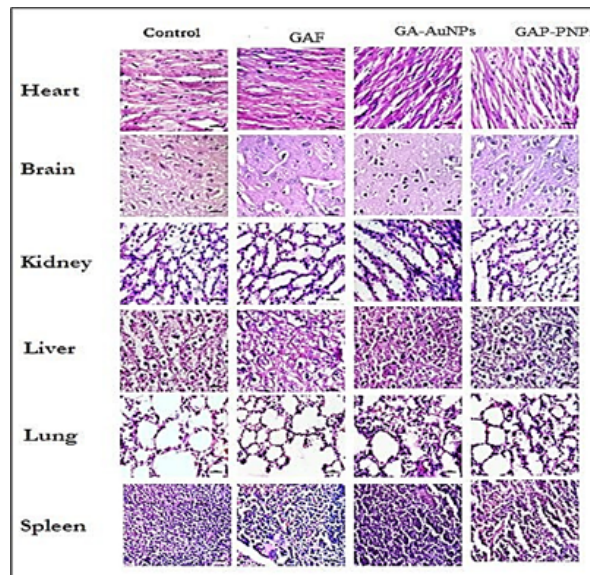


Figure 3: Histopathology of organs-subacute toxicity studies.

Table 1: Percentage yield of the Folic acid fraction

Parameter	<i>P. vulgaris</i> L. seed's Folic acid fraction
% Yield (% weight/weight)	14.30 % w/w
Colour	Dark brown
Consistency	Powder Crystals

Table 2: α -amylase inhibitory activity of folic acid fraction

Sample	Concentration (mg/mL)	%inhibition
Folic acid fraction	05	17.492 \pm 0.24
	010	14.233 \pm 0.13
Acarbose fraction	01	48.214 \pm 0.22

the cells that make up this layer no longer seem to be as distinct from one another as they were in the past. Following the completion of the ovule's developmental process, the integuments are the ones responsible for the formation of the seed coat's multiple layers. The palisade wall that surrounds the seeds of most legumes is composed of outer layer, which may also be referred to as the epidermis.

Fractionation and Extraction

The percentage yield of folic acid fraction (FAF) from *P. vulgaris* L. were tabulated in Table 1.

Pharmacological Screening

α -Amylase Enzyme-inhibition

It was found that seeds of the plant had a component of the folic acid that had the ability to block the activity of the enzyme α -amylase. The comparisons made in Table 2 between the different concentrations of the folic acid fraction and the gold standard medicine acarbose reveal that the maximum inhibition occurs at 5 and 10 mg/mL, concentrations, respectively, for the folic acid fraction. In light of these results, it would

Table 3: Hematic parameters.

	Group				
	Week	Vehicle + Normal diet	Vehicle + HFD	HFD + <i>P. vulgaris</i>	HFD + Acarbose
Glucose (mg/dL)	13	101.0 \pm 3.5	139.3 \pm 6.8	103.0 \pm 5.2	132.0 \pm 9.8
	15	99.0 \pm 10.1	149.5 \pm 3.9	103.0 \pm 8.0	113.3 \pm 7.4
	17	103.3 \pm 6.4	138.5 \pm 9.1	127.8 \pm 2.0	121.0 \pm 5.9
	19	99.3 \pm 4.6	137.3 \pm 9.4	112.0 \pm 4.4	116.3 \pm 5.7
Triglycerides (mg/dL)	13	62.0 \pm 6.9	132.3 \pm 11.3	123.0 \pm 18.0	105.0 \pm 14.6
	15	72.3 \pm 13.6	135.3 \pm 6.0	86.5 \pm 10.7	93.3 \pm 10.4
	17	78.4 \pm 2.7	136.8 \pm 2.3	105.3 \pm 7.8	113.8 \pm 5.8
	19	75.8 \pm 11.0	133.5 \pm 7.7	107.5 \pm 9.3	118.3 \pm 3.7
Total cholesterol (mg/dL)	13	<100	133.7 \pm 4.4	104.3 \pm 3.5	128.6 \pm 8.2
	15	105.0 \pm 5.0	135.8 \pm 1.3	103.0 \pm 2.3	118.3 \pm 7.2
	17	107.0 \pm 1.2	147.0 \pm 2.8	123.0 \pm 6.4	139.3 \pm 12.5
HDL (miligram/dL)	19	103.8 \pm 4.1	147.3 \pm 4.1	100.5 \pm 7.6	103.9 \pm 9.2
	19	51.8 \pm 8.6	62.3 \pm 7.1	41.7 \pm 10.3	59.1 \pm 10.4
LDL (miligram/dL)	19	43.8 \pm 6.8	62.3 \pm 7.1	38.4 \pm 6.2	46.0 \pm 9.5

At weeks 13, 15, 17, and 19, blood glucose, triglyceride, and total cholesterol concentrations were evaluated to assess the impact of a high-fat diet (HFD) and treatment options. At the 19th week, we also checked the HDL and LDL levels. The animals were randomly assigned to a control or HFD group within the first week. Beginning in week 11, daily oral administration of 500 mg/kg of *P. vulgaris* extract and 100 mg/kg of acarbose was administered.

Table 4: Behavioral Alterations Caused by Acute Toxicity

FA-AUNPs	FAF (1g and 2 g/kg)	FAP-PNPs	Parameters
Nil	Nil	Nil	Aggressiveness
Plus	Plus	Plus	Alertness
Nil	Nil	Nil	Convulsion
Nil	Nil	Nil	Corneal reflex
Nil	Nil	Nil	Gripping strength
Nil	Nil	Nil	Lacrimation
Plus	Plus	Plus	Pain response
Plus	Plus	Plus	Pinna reflex
Regular	Regular	Regular	Skin colour
Plus	Plus	Plus	Touch response
Nil	Nil	Nil	Tremors
Regular	Regular	Regular	Urination
Nil	Nil	Nil	Writhing
Nil	Nil	Nil	Mortality

Table 5: The effect of FAF, FA-AUNPs and FAP-PNPs on weight changes

Group	Weight	Body Weight (g) (Weeks)			
		1	2	3	4
Normal	155.60 ± 10.15	160.32 ± 14.50	162.40 ± 12.10	163.20 ± 14.24	163.50 ± 09.75
FAF 100 mg/kg	162.74 ± 10.22	164.32 ± 11.20	175.29 ± 10.25	186.28 ± 11.94	190.20 ± 10.48
FA-Au NPs 0.5 mg/kg	160.26 ± 8.21	163.56 ± 14.13	172.16 ± 11.46	179.15 ± 11.28	188.21 ± 12.37
FAP-PNPS 0.5 mg/kg	159.66 ± 7.14	1632.46 ± 24.16	166.14 ± 10.22	174.16 ± 10.28	126.22 ± 16.58

n=6, and results are presented as a mean standard error of the mean. An individual analysis of variance (ANOVA) was performed, and then a multiple comparison test (turkey) was used to draw conclusions. Compared to a control group, the values are statistically significant at 0.05.

Table 6: The effect of FAF, FA-AUNPs and FAP-PNPs on hematological parameters

S. No.	1	2	3	4	5	6	7	8	9	10	11
Parameters	RBC (102/μL)	Hb (g/dl)	MCV (fL)	MCH (pg)	MCHC (gm./dl)	WBC (102/μL)	Neutrophils (%)	Eosinophil (%)	Basophils (%)	Lymphocyte (%)	Monocyte (%)
Control	07.64 ± 0.55	14.32 ± 1.00	62.62 ± 06.58	18.76 ± 04.54	34.40 ± 02.68	07.30 ± 02.05	20.20 ± 02.46	01.18 ± 02.04	00	66.13 ± 0.34	02.08 ± 0.23
FAF 100mg/Kg	07.24 ± 0.02	13.59 ± 0.14	52.06 ± 0.12	16.98 ± 0.14	32.43 ± 0.28	06.48 ± 0.3	24.16 ± 0.08	02.07 ± 0.15	00	63.24 ± 0.28	02.06 ± 1.2
FA-AuNPs 0.5mg/kg	07.34 ± 0.24	15.53 ± 0.06	54.36 ± 0.55	17.54 ± 0.46	34.84 ± 0.54	06.54 ± 0.38	24.42 ± 0.07	01.44 ± 0.18	00	65.89 ± 0.55	01.94 ± 0.06
FAF-PNP's 0.5mg/kg	07.52 ± 0.20	15.21 ± 0.07	55.36 ± 0.05	17.60 ± 0.28	34.52 ± 0.60	06.95 ± 0.88	24.62 ± 0.20	01.28 ± 0.02	00	64.78 ± 0.11	01.74 ± 0.52

The mean and standard deviation were determined using data from six individuals. Blood contains several different substances, including hemoglobin (Hb), red blood cells (RBCs), platelets, and white blood cells (WBCs).

Table 7: The effect of FAF, FA-AUNPs and FAP-PNPs on biochemical parameters

S. No	Control	FAF 100 mg/Kg	FA-AuNPs 0.5 mg/kg	FAP-PNPS 0.5 mg/kg	Parameters (mg/dl)
1	102.63 ± 4.21	101.45 ± 2.87	105.52 ± 2.85	103.55 ± 2.98	Glucose
2	044.16 ± 1.91	042.43 ± 1.94	046.66 ± 1.44	041.64 ± 2.26	Cholesterol
3	078.74 ± 2.78	076.44 ± 2.64	076.68 ± 2.66	078.34 ± 2.89	Triglyceride
4	104.16 ± 8.08	104.32 ± 8.65	104.78 ± 8.98	105.33 ± 8.71	HDL
5	078.34 ± 2.66	078.45 ± 2.22	078.58 ± 1.88	076.22 ± 2.67	LDL
6	007.13 ± 0.28	007.22 ± 0.24	007.28 ± 0.33	007.48 ± 0.48	Protein
7	003.12 ± 0.40	003.06 ± 0.66	003.6 ± 0.76	004.2 ± 0.89	Albumin
8	003.14 ± 0.05	003.38 ± 0.09	003.84 ± 0.55	003.67 ± 0.44	Globulin
9	000.22 ± 0.05	000.16 ± 0.01	000.45 ± 0.06	000.28 ± 0.03	Creatinine
10	058.50 ± 0.70	054.32 ± 0.54	054.66 ± 0.78	058.38 ± 0.48	Urea
11	054.20 ± 1.24	052.37 ± 0.24	056.27 ± 1.54	052.28 ± 1.55	AST (IU/L)
12	025.32 ± 1.88	026.31 ± 1.66	022.28 ± 1.32	026.28 ± 1.78	ALT (IU/L)
13	062.46 ± 3.32	060.36 ± 2.68	062.26 ± 2.87	064.24 ± 3.48	ALP (IU/L)

Standard error of the mean for a sample size of 6 is displayed for all numbers. One-way analysis of variance (ANOVA) and the turkey-multiple-comparison test were used to examine the relationships between HDL = high-density lipoprotein, LDL = low-density lipoprotein, AST = aspartate transaminase, ALT = alanine transaminase, and ALP = alkaline phosphatase (TMCT).

seem that ingesting this FAF produced from *P. vulgaris* L. may greatly decrease the quick digestion and absorption of carbohydrates, hence promoting improved diabetes control via lower postprandial glucose levels.

Hematic Metabolic Parameters

Blood levels of glucose, total cholesterol, and triglycerides were tested twice per month at this stage. Before administering the medications, the aforementioned hematic parameters were considerably higher in the fat-fed animals compared to the control animals.

Toxicology and Safety of Extracts from *P. vulgaris* Alpha-Amylase Inhibitor

Acute Toxicity Studies

A study of the acute toxic effects was carried out wherein the effects on the animals were monitored for overall health and behavior by orally delivering FAF, FA-AUNPs, and FAP-PNPs. This was done to understand these compounds' effects on the mammalian body. No deaths were observed at doses as high as 2 g/kg for the FAF of *P. vulgaris* L. Seed and 50 mg/kg equivalent for the formulations. Throughout the whole of the

Table 8: The effect of FAF, FA-AUNPs and FAP-PNPs on animal organ weight

Control	FAF-100 mg	FA-AuNPs 0.5 mg/kg	FAP-PNPs 0.5 mg/kg	Organ (g)
03.12 ± 0.11	03.22 ± 0.11	02.86 ± 0.08	02.55 ± 0.25	Liver
00.43 ± 0.05	00.32 ± 0.03	00.34 ± 0.01	00.32 ± 0.12	Heart
00.54 ± 0.13	00.54 ± 0.13	00.65 ± 0.09	00.56 ± 0.16	Lung
00.55 ± 0.05	00.66 ± 0.09	00.33 ± 0.04	00.87 ± 0.26	Spleen
01.72 ± 0.29	01.87 ± 0.19	01.32 ± 0.17	01.45 ± 0.16	Ovary
02.23 ± 0.13	02.57 ± 0.10	02.60 ± 0.09	02.32 ± 0.28	Testes
01.15 ± 0.15	01.98 ± 0.09	01.55 ± 0.11	01.22 ± 0.17	Brain
00.65 ± 0.06	00.32 ± 0.04	00.66 ± 0.06	00.98 ± 0.23	Kidney
01.24 ± 0.12	01.38 ± 0.11	01.20 ± 0.11	01.21 ± 0.18	Stomach

The mean and standard deviation were determined using data from six individuals. Separate ANOVAs were performed on each of the variables, and the results were compared using a series of post-hoc tests (turkey). These findings are not statistically significant compared to the control group's mean value.

study, every animal exhibited behavior consistent with its species, and any significant departures from this pattern was not observed till the completion of the study. On the basis of these findings, it would seem that the FAF of *P. vulgaris* L. Seed is safe up to the maximum tolerated dose (MTD) of 2 gm per kg of body weight, which is recommended by OECD standards 423. On the basis of these findings, the dosage of one-tenth of the maximum tolerated dose, which is 100 mg/kg, was chosen as the effective dose for the remaining pharmacological studies. An acute toxicity model investigation conducted in accordance with OECD standards 423 revealed that the maximum tolerated dose, abbreviated as MTD, is 5 mg per kg of body weight. As a direct consequence, the chosen dose was 0.5 mg/kg, equivalent to one tenth of the MTD. In addition, the dose for the formulations chosen for use in pharmacological research was reduced to one-tenth of the original amount. As can be seen in Tables 1-8, the oral administration of FAF, FA-AuNPs, and FAP-PNPs to mice for a period of 24 hours at dosages of 1–2 gm/kg and 5 mg/kg body weight, respectively, does not result in any observable indicators of toxicity or mortality in the mice. This is the case even when the mice are given 1–2 gm/kg dosages. This indicates that the extract is for use in medicinal applications. The LD₅₀ values for FAF, FA-AuNPs, and FAP-PNPs may be higher than what was seen in the trials. Table 4 presents the results of the investigation.

Sub-acute Toxicity Studies

The results of the hematological tests performed on day 28 showed significant changes in the values of the various parameters compared to the controls' values. These variations were detected in comparison to the values of the controls. No discernible departures from the normal range of biological and laboratory values were detected. The conclusive findings are shown in Table 5 through 2.15. Figure 3 also presents these histology findings for your perusal.

DISCUSSION

The severity of the disorders that comprise metabolic syndrome, including high blood sugar, insulin resistance, high cholesterol, obesity, atherogenic events, and the deposit of fat in the liver, contribute to its significance. All of these

symptoms might make it more likely that a person will develop type 2 diabetes or cardiac complications. Therefore, there is a significant need for drugs that can address one or more of these issues while only causing a limited number of very mild adverse effects. During the course of this research, a mice model was developed for studying the inhibition of metabolic syndrome. With this model's help, we could evaluate the degree to which a standard extract from *P. vulgaris* seeds protects against glycemic control. Its efficacy was evaluated in comparison to that of two reference medications, metformin and atorvastatin, which are used to treat excessive blood sugar and high cholesterol levels, respectively. The fact that we were able to demonstrate that the natural material had the same plus benefits as the reference medicine and in some cases even performed better is one of the most exciting aspects. The unique aspect of this study was examining how daily treatment with an extract of *P. vulgaris* for eight weeks altered all of the symptoms associated with metabolic syndrome. Pain, changes in motor function, and elevations or decreases in blood sugar, triglycerides, or cholesterol are all examples of such symptoms. Rats were given *P. vulgaris* L. FAF in this study. They continued to consume seed for a total of 28 days, during which time they all survived. During the trial, there were no indications that anything may potentially be harmful. Rats that were fed varying quantities of FAF that was produced from the seed of *P. vulgaris* L. gained weight in a manner that was dynamic over the course of many weeks. Because the control group did not experience this sort of weight increase (p < 0.05), this observation is quite significant.

SUMMARY AND CONCLUSION

Black bean (*P. vulgaris*) is a global dietary staple. Due to its inexpensive cost and high micronutrient, protein, and fibre content, the black bean spread from South America to the rest of the globe. One cup of black beans offers over 20% of 10 nutrients. Black bean is satiating and low-glycemic. Black beans may fit into practically any diet as a side dish or main vegetarian meal. Black beans may protect against cardiovascular disease, cancer, obesity, and diabetes. High fiber-protein levels and flavonoid and phenolic content provide black beans

their health benefits. The current standardized *P. vulgaris* extract effectively nullifies molecular, biochemical, and behavior alterations generated by HFD in a metabolic syndrome paradigm. *P. vulgaris* extract's broad spectrum of activities and well-established safety make it a promising therapeutic option.

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