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# Phaseolus Vulgaris L., or Common Bean, Has A Wide Variety of Chemicals in its Whole Seed Form

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***Abstract:*** ***The Phaseolus vulgaris L. bean, also known as the common bean, is a very valuable crop that is grown and eaten all over the world. P. vulgaris is an important food crop because it has a lot of protein, carbs, and fiber. Some people think that bean starch is harder to break down than grain starch. This is due to the fact that bean starch has a high concentration of amylose, a long amylopectin branch chain, and a backwards tilt. Beans have many different parts, such as peptides, tocopherols, unsaturated fatty acids, and phenolic compounds. Scientists have found that the way beans are made chemically is linked to many important biological processes. Antioxidant, antibacterial, antihyperglycemic, and anticancer properties are some examples of these biological effects. This study gives a summary of the complex chemical makeup of whole common bean seeds and how it relates to the seeds' nutritional and functional qualities.***
***Keywords: Phaseolus vulgaris, phenolic compounds, amylopectin branch, tocopherols, antihyperglycemic, chemical composition***

## I. INTRODUCTION

Pulses, which are often starchy legume seeds, are an important source of protein for millions of people, especially in poor countries. They also provide calories (in the form of starch) and fiber. Dry beans are a type of bean seed that is made up of a starchy substance called a legume. They can be used in many different meal plans, are cheaper than meals made from animals, and have the same amount of protein. Beans have tocopherols, phenolic compounds, peptides, amino acids, dietary fiber, resistant starch, unsaturated fatty acids, and minerals (3 g/kg Ca; 40 mg/kg Fe; 35 mg/kg Zn). There are many biological reactions that can be done with these chemicals. Figure 1 shows the chemical parts that make up a bean seed. Several types of research have shown that eating beans is good for your health. There is evidence that the parts of beans that aren't needed for nutrition may help prevent colon, breast, and prostate cancers and lower blood cholesterol and glycemia. The goal of this paper is to give an overview of the chemical parts of Phaseolus vulgaris that, when eaten by people, cause different biological responses.

## II. THE STARCH AND THE FIBER

Beans are the best way to get your daily dose of fiber. Fiber-wise, they have two to three times as much fiber per 100 g of edible part as other foods. But in wealthy countries, where beans have been replaced by other foods, the amount of fiber in the diet has dropped by a lot (cereals, meats, and dairy products). Along with dietary fiber and fermentation products, the resistant starch in common beans has been linked to keeping digestive health, especially colon health, in check. Rice and beans, which come in many different kinds like black beans, Carioca beans, and common beans, make up a big part of the Brazilian diet. In a randomized cross-over experiment with 12 healthy adult women, the effects of black beans and chickpeas on blood sugar levels after eating rice were studied. In a randomized, controlled study with a cross-over design, the three treatment groups were white rice, black beans and white rice, and chickpeas and white rice. White rice was the control group. In each treatment, 50 grams of carbohydrates that are easy to digest were used. At 30, 60, 90, and 120 minutes, the amount of glucose and insulin in the blood was checked. At 60, 90, and 120 minutes after eating, the black beans and white rice were less healthy than the control meal (only white rice). The research shows that eating 1.5 cups of beans every day might help lower blood sugar levels after meals. A plant-based diet also has other health benefits, such as a lower risk of getting some long-term diseases and a stronger digestive system. The fact that bean starch is C-type polymorphic and has higher amylose concentrations than almost all other commercially available starches affects how it is broken down. Beans have phytic acid, tannins, and a-amylase inhibitors, all of which can make it harder to digest starch. Demiate and his colleagues looked at how well starches from two Brazilian bean species, Phaseolus vulgaris and Vigna unguiculata, could be digested in a test tube and how they were put together. The amount of amylose found in the beans was between 27.0% and 35.9%. The research showed that there were different patterns for how easy it was to digest the starch in different kinds of beans.

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The white kidney beans had the most resistant starch (7.4%), while the red kidney beans had the least amount of digestible starch (89.2%). After analyzing the chemical make-up, functional properties, and starch digestibility of twenty-five different types of dry beans grown in Michigan, researchers looked into how to make cookies with beans as the main ingredient. It was found that bean flours worked best for this kind of meal, and the fact that the cookies had a lot of resistant starch and protein was emphasized. People have said that, by dry weight, common beans have anywhere from 55.65% starch to 66.45% dietary fiber and oligosaccharides. Some polysaccharides can be broken down by bacteria in the large intestine, while others can't be broken down at all (these are the resistant starch and fiber). Both of these things can be turned into alcohol.

Beans have a much higher amount of resistant starch than grains like maize, wheat, and rice. Possible reasons for this difference include differences in the amount of bean amylose, the length of the amylopectin branch chain, how crystallized the starch is, and the size of the granules. Due to the high amount of amylase inhibitors, phytates, and fiber in the food, starch digestion may be slowed down and less starch may be digested. In order to improve people's health quickly and for a low price, these authors think that beans should be encouraged as functional meal components. Lestari and her coworkers made low-glycemic-index cookie bars with kidney beans as one of the ingredients. Adding beans to meals and changing the ingredients in processed foods are two ways to lower glycemic loading. Both of these things could have big health benefits for people. Beans have a low glycemic index compared to other high-carbohydrate foods because they are high in fiber and have a lot of slowly digesting starch. Compared to other meals with a lot of carbs, this one is a great deal. In a study of people with metabolic syndrome, researchers found that eating whole black beans made people feel fuller, gave them more protein and other nutrients, and may have had bioactive components that were good for their health.

**Table 1**: Displays the chemical make-up of whole beans in all their splendour:

**Table 1**

**Chemical composition (% m/m, on dry basis) of raw (uncooked) common beans (*Phaseolus vulgaris* L.).**

| Sample description | Ash | Lipids | Protein | Total carbohydrates[a] | Total starch | Insoluble dietary fiber | Soluble dietary fiber | Total dietary fiber | Reference |
|---|---|---|---|---|---|---|---|---|---|
| Dark bean seeds | 3.8 ± 0.0 | 1.1 ± 0.1 | 17.7 ± 0.5 | 77.4 | – | 21.5 ± 3.4 | 5.8 ± 1.1 | 27.2 | [7] |
| Common black beans | 3.9 ± 0.10 | 2.7 ± 0.06 | 23.0 ± 0.25 | 70.3 | – | – | – | – | [1] |
| Common black beans | 5.7 ± 0.0 | 1.8 ± 0.3 | 24.2 ± 1.1 | 66.6 | – | – | – | 1.7 ± 0.3[b] | [20] |
| Common black beans | – | – | – | – | 45.6 ± 1.12 | 32.8 ± 0.78 | 2.9 ± 0.67 | 35.7 | [21] |
| Common beans | 4.1 | 1.9 | 21.7 | 58.8 | | – | – | 4.0[b] | [22] |
| Black beans | 4.6 | 1.7 | 20.3 | 73.4 | | – | – | – | [23] |
| 'Carioca' beans | 3.9 | 0.7 | 22.5 | 72.9 | | – | – | – | [23] |
| Common beans | 3.2 ± 0.06 | 2.7 ± 0.09 | 24.1 ± 0.97 | – | 44.8 ± 0.69 | – | – | 3.9 ± 0.04[b] | [24] |
| Common black beans | 4.0 | 1.5 | 26.8 | 65.4 | | – | – | 2.3[b] | [25] |
| Common beans | 4.6 | 1.6 | 24.0 | 61.3 | 41.8 | – | – | 2.2[b] | [26] |
| Common beans | – | – | – | – | | 13.9 ± 1.1 | 7.7 ± 1.0 | 25.8 ± 1.1[c] | [11] |
| Kidney beans | 4.2 | 1.9 | 27.9 | – | | 29.9 | 8.3 | 38.2 | [27] |

[a] Calculated by difference.
[b] Crude fiber.
[c] Includes raffinose + stachyose + verbascose (4.2 ± 0.4).

## III. PEPTIDES

Hydrolysis of peptides, which happens during digestion, can be used to get peptides from sources outside of the body. Fermentation and the controlled breakdown of proteins with enzymes or proteolytic bacteria are two other ways to make these compounds. Several studies have been done on the peptides in beans, and the results are promising, suggesting that they may have antibacterial, antioxidant, antithrombotic, and antihypertensive effects. Dipeptidyl peptidase IV (DPP-IV), a-amylase, and a-glucosidase are enzymes that are linked to type 2 diabetes. Angiotensin converting enzyme is an enzyme that is linked to high blood pressure (ACE). The most important bioactive property of peptides is that they can stop ACE from working. Angiotensin I-converting enzyme (ACE) is a key enzyme for keeping blood pressure in check. In the body, its main job is to change angiotensin I into angiotensin II. There are two ways that angiotensin II causes blood pressure to go up. At first, it makes the blood vessels narrow, but it also breaks down bradykinin, which makes the blood vessels widen.

Blood pressure goes up because of these two things. In the research that Ruiz-Ruiz and his colleagues did, they found that the molecular weight of the peptide in the hard-to-cook bean made it more effective at stopping ACE from working. Peptides with a lower molecular weight were better at stopping a-amylase and acting as antioxidants than those with a higher molecular weight. In their first study, Mojica and his colleagues show that peptides made from common beans can stop a-amylase and a-glucosidase from working. Scientists found that cooking the common bean didn't change its ability to stop ACE activity. But the sample of beans that had already been cooked showed less DPP-IV inhibition. Jakubczyl and his colleagues showed that lipase, a-amylase, and ACE are stopped by peptides with molecular weights between 3.5 and 7 kDa. These peptides are made by fermentation. Conditions for fermentation that made the most effective peptides that blocked ACE and a-amylase were different from those that made the most effective peptides that blocked lipase. ACE and a-amylase enzymes are blocked. Ngoh and his colleagues used a pancreatic cell culture assay to see if commercially available Pinto bean peptides could stop a-amylase activity (AR42J). The peptide with the lowest IC50 value is the one with a molecular weight of 1.6 kDa. Its IC50 value is 0.31 mM. Diabetes type 2 may be easier to control or get rid of if you take a-amylase and a-glucosidase inhibitors, which stop enzymes from breaking down starch and sugar into their simpler forms. DPP-IV is an enzyme that stops hormones like GIP (glucose-dependent insulinotropic polypeptide) and GLP-1 from working. This suggests that peptides found in beans could be used to treat type 2 diabetes (glucagon-like peptide-1). It is the job of these hormones to keep blood sugar levels steady, which controls hunger and slows the emptying of the stomach. Bean peptides were found to help control glucose absorption by making pancreatic cells make more insulin and reduce fat buildup in adipocytes. Adipocytes are a type of cell that stores and releases glucose. Bean peptides also helped keep the body from taking in too much sugar. Scientists thought that peptides made from beans might be a good new way to stop people from getting type 2 diabetes.

## IV. PHENOLIC COMPOUNDS

Beans have a wide range of phenolic compounds, such as tannins, flavonoids, anthocyanins, flavonols, flavanols, isoflavones, flavanones, proanthocyanidins, flavonols, and phenolic acids. Flavonoids are one type of phenolic compound that beans have. These chemicals are found naturally in beans that you can eat, and they are often taken out by mixing hydrophilic solvents with water, like 80% methanol. These substances can also be bonded to polysaccharides in the cell wall or exist as insoluble conjugates with soluble oligosaccharides and peptides (allowing for release upon alkaline hydrolysis). Chen and his team showed that flavonoids are often found in their free forms, while phenolic acids are usually found in their bound or conjugated forms. Different bean species have different amounts of free, conjugated, and bound phenolics (7%-59%, 28%-76%, and 8%-18%), according to the author's research. Giusti and his team used HPLC-DAD to figure out how much phenolic compounds were in each pulse. Gallic acid levels were between 3.1 mg/kg and 7.1 mg/kg, chlorogenic acid levels were between 24 mg/kg and 239.2 mg/kg, catechin levels were between 10 mg/kg and 614.3 mg/kg, epicatechin levels were between 17.7 mg/kg and 279.2 mg/kg, syringic acid levels were between 3.7 mg/kg and 12.6 mg/kg, and kaempferol-3-glucoside levels were between 24.5 mg/kg There were a total of 649.5 mg/kg of anthocyanins (delphinidin 3,5-diglucoside and cyanidin-3-glucoside) in black beans. But DPPH found that Verdolino beans had the most powerful ability to get rid of free radicals. The phenolic makeup of common beans changes when they are cooked or sprouted before they are eaten. So, it's important to point out this difference. Lopez and his coworkers say that raw black beans have the most phenolic chemicals, which are the same as anthocyanins. When the beans were boiled, the amount of anthocyanins in them dropped by 68%, but after seven days of germination, it was back to where it was before they were boiled.

Researchers led by Guajardo-Flores found that the seed coats of black beans had the most phenolics and antioxidant activity on the third day after they started to sprout. Jimenez-Monreal and his colleagues showed that green beans kept their antioxidant activity even after being cooked in the usual way. Also, in the modern world, it's important to have natural alternatives to chemicals and preservatives made from man-made materials for storing and improving food. Gan and his colleagues found that extracts of the colored bean coat had flavonoids and proanthocyanidins with high levels of antioxidant and antibacterial activity. This suggests that they might be a good way to keep food fresh. Then, it has been suggested that these chemicals be taken from things that have lost their value, like beans with tough skins that make them hard to cook.

## V. FATTY ACIDS, TOCOPHEROLS, AND CAROTENOIDS

The oil content of seven different cultivars of the cranberry bean, or P. vulgaris, ranged from 1.73 to 1.98 percent. Even though common beans are not oil seeds, they contain a lot of unsaturated fatty acids. There are many different fatty acids in common beans, but linoleic acid (C18:2n6) and linolenic acid make up between 62 and 83% of them (C18:3n3). The second and third most common fatty acids are palmitic (C16:0) and oleic (C18:1n9) acids, respectively.

Beans may be good for your health because they have less omega-6 fatty acids than omega-3 fatty acids. Beans have a lot of omega-3 polyunsaturated fatty acids, which is why (PUFA). Only b-carotene has been found among the carotenoids. When cranberry beans were tested for tocopherols, g-tocopherol was found. This is an antioxidant that helps protect unsaturated fatty acids. However, when cranberry beans were tested for carotenoids, only b-carotene was found in very small amounts.

## VI. ANTINUTRITIONAL FACTORS

Beans have compounds that aren't good for you, like phytic acid, a trypsin inhibitor, lectins, and some oligosaccharides. These things make it harder to absorb minerals because they make it harder to digest and absorb minerals. Beans are being studied for their anti-nutritional components, which may turn out to be valuable bioactive compounds in the future due to their huge potential for human and animal nutrition. The main raffinose family oligosaccharides (RFOs) in common beans are raffinose, stachyose, and verbascose. These are considered prebiotics because they help good bacteria like bifidobacteria and lactobacilli grow in the colon. The a-galactosidase enzyme is only found in the small intestine of mammals with more than one stomach. Because of this, the RFOs end up in the large intestine, where they ferment and make flatus. Oligosaccharides can cause gas, but they are not harmful and can be lessened by soaking beans before eating them. This has more benefits than just the effect on prebiotics that we talked about above. You can lower your glycemic index by eating foods that are high in oligosaccharides, fiber, resistant or indigestible starch, and other types of starch. We used open fermentation to make the protein easier to digest and reduce the amount of substances in the bean seeds that are bad for your health. Lactic acid bacteria may get rid of oligosaccharides because they need raffinose and stachyose to live. By weight, beans can have between 0.4% and 0.6% of the antioxidant phytic acid (PA). PA may also be found in cereals, vegetables, nuts, and natural oils. It is considered an antinutrient because it binds strongly to the cations in minerals like calcium, iron, magnesium, and zinc. This is because it makes it hard for the body to digest and absorb these nutrients. Because PA might stop the production of reactive oxygen species, it can be used to prevent and treat a wide range of diseases. Trypsin inhibitors are very important when it comes to stopping proteases from working. Adeyemo and Onilude found that eating foods with trypsin inhibitors causes pancreatic hyperplasia and changes to the body's metabolism. This is because these foods stop the body from digesting protein properly. When protease inhibitors are used, the bioavailability of sulfur-containing amino acids goes down and protein is passed out of the body. With thermal treatments, the amount of this and other chemicals that are bad for nutrition, as well as their harmful effects, can be cut down. If tannins bind to minerals or proteins, they may slow down digestion and make it harder for the body to absorb nutrients. Several hydrogen bonds form between the hydroxyl groups of tannins and the carbonyl groups of proteins. This is how the tannin-protein complex is made. Tannins can bind to both the proteins in food and the digestive enzymes that help break them down. This makes complexes that are hard to break down. lectins, which are sometimes called hemagglutinins, are proteins that bind to sugar and may cause red blood cells to stick together. Animals that eat lectins don't grow and develop as well because they can't digest them and get the nutrients they need. Nciri and her group of researchers looked into whether or not common beans were poisonous. People who eat beans before they are cooked may feel sick, throw up, or have diarrhea for a short time. They discovered that this was true. On the other hand, beans may have less lectin after they have been processed. Over 90% of the phytohemagglutinin (PHA) was taken out during the extrusion process and the steam heating process, both of which were done at 82 degrees Celsius with respect to the raw bean flour. Kelkar and his other coworkers showed this. In the same way, the material can have less PHA if it is treated with water, heat, or both (by soaking, boiling, or autoclaving).

## VII. CONCLUSION

Beans are a healthy and nutritious food choice because they have almost twice as much protein and fiber as grains. They also contain a lot of bioactive molecules, some of which, despite being bioactive, are considered to be anti-nutritional factors and others to be non-nutritional dietary components. Because beans have a lot of fiber, resistant starch, and bioactive phytochemicals, they can be used in a wide range of healthy dishes. After a few months, it's hard to cook common beans, which makes them less valuable from an economic point of view. We need to fund research projects that promote the use of low-value seeds if we want the food business to use them.

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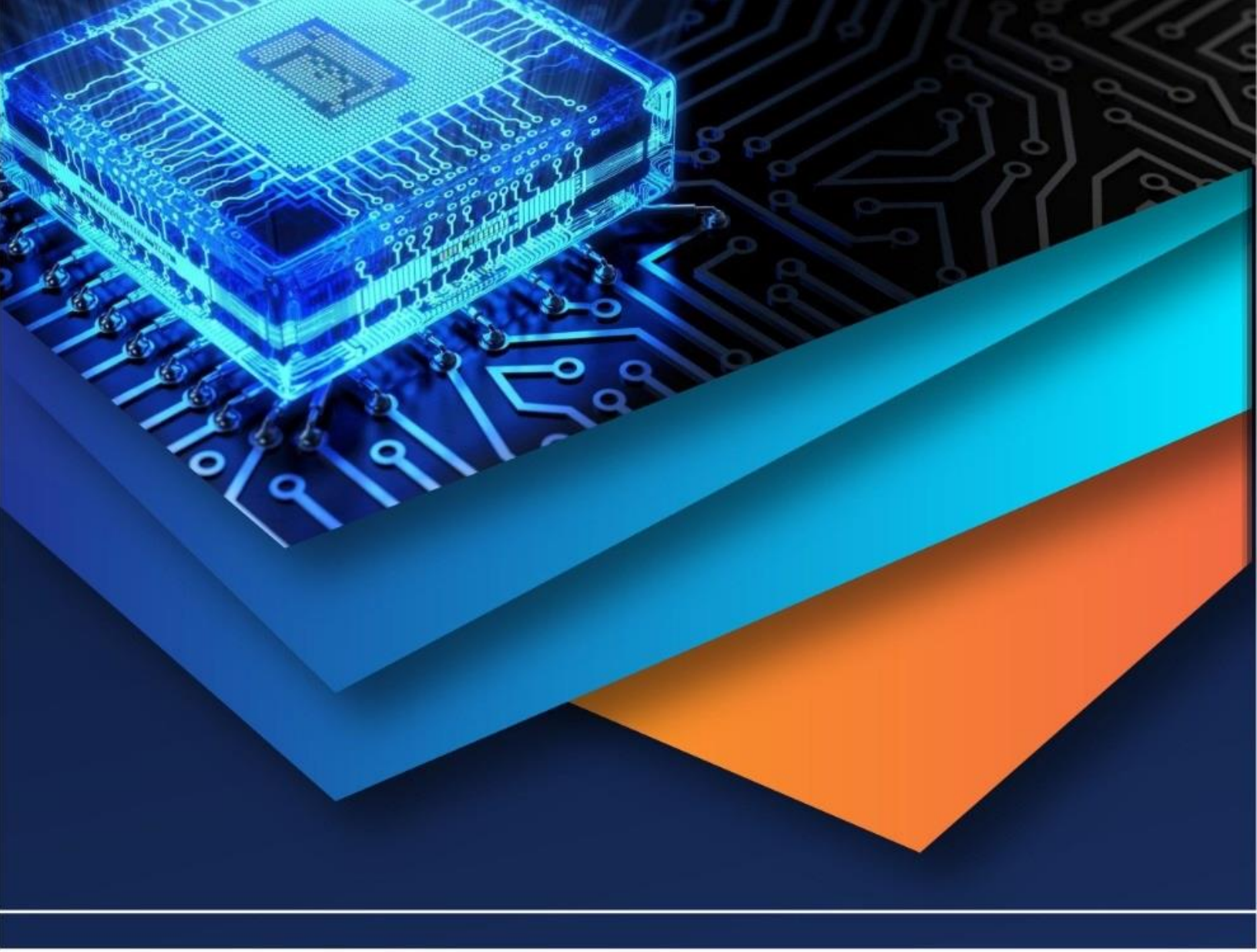

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