Chemistry of the Nutritional and Health Benefits of my Favorite Garbanzo Beans Dish

Garbanzo beans, also known as chickpeas, are the most frequently consumed legume in the world.\(^1\) They originated in the Middle East and are today grown in India, Australia, Pakistan, Turkey, Burma, Ethiopia, and Iran.\(^1\) These beans can also be found in the Mediterranean and western Asia.\(^1\) India is the largest producer of garbanzo beans in the world, producing more than fifteen times the amount as Australia, the second-largest producer.\(^1\) Garbanzo beans are typically harvested in late spring and summer.\(^2\) There are two primary types: Desi and Kabuli, which differ in appearance and region grown.\(^2\) Desi are darker and rougher, while Kabuli are lighter, larger, and smoother.\(^2\) Typically, garbanzo beans must be shipped four to five months after being harvested.\(^2\) Long periods of storage makes them susceptible to pests, such as weevil.\(^2\) They are stored in an air-tight container, typically a can.\(^2\) Garbanzo beans can be found at local Columbia grocery stores, including HyVee, Schnucks, Lucky’s, and Walmart.\(^3\) A 12 pack of 15 ounce cans of garbanzo beans typically costs about $16.59 at Walmart.\(^3\) Online at Amazon, non-GMO project verified garbanzo beans cost $14.95 for a five pound burlap bag.\(^4\) Garbanzo beans can be used for many different foods, including salads, soups, dips, hummus, pasta, etc. The uses of garbanzo beans are endless, and they can even be used to make healthy desserts, such as peanut butter chocolate chip cookies made with garbanzo beans (Appendix A).\(^5\)

References


<http://www.cargohandbook.com/index.php/Chickpeas>

<http://www.amazon.com/Non-GMO-Verified-Garbanzo-Non-Irradiated-Certified/dp/B001PEWJWC>

Nutritional and Health Benefits of Garbanzo Beans

There are numerous nutritional and health benefits associated with garbanzo beans. Some of these benefits include being high in fiber, controlling insulin and blood sugar secretion, helping with digestive support, providing protein, producing manganese for energy, boosting iron, being heart healthy, helping with weight loss, and reducing the risk of breast cancer. The many vitamins and minerals in garbanzo beans include calcium, manganese, molybdenum, folic acid, iron, copper, zinc, and magnesium. Specifically, a garbanzo bean seed is composed of 38 to 59% carbohydrates, 3% fiber, 4.8 to 5.5% oil, 3% ash, 0.2% calcium, and 0.3% phosphorus. All of these vitamins and minerals have various positive effects on health. A typical cup of garbanzo beans contains about 15 grams of protein and 12.5 grams of fiber. The recommended daily intake is about 46 to 56 grams for protein and about 25 to 30 grams for fiber. Both protein and fiber are integral components of a healthy diet. One cup of garbanzo beans almost amounts to a full serving per day of protein and fiber. Garbanzo beans can be an important source of protein for vegans or for anyone who does not get enough protein through their diet. Garbanzo beans are also very important for those with blood sugar problems, such as diabetes, because they contain very high fiber and thus have a low glycemic index. Garbanzo beans are a very low-fat food and can be extremely beneficial for weight loss and digestive track maintenance.

The vitamins, minerals, macronutrients, and phytochemicals all contribute to the healthiness of garbanzo beans. Because garbanzo beans are high in protein, they provide a lower calorie option when combined with whole grains. They contain 84.5% of the daily-recommended value of manganese, a key component for energy production and antioxidant defenses. Garbanzo beans are rich in iron, and therefore boost energy, something of particular importance for menstruating or pregnant women and growing children.
the phytochemical saponin, an antioxidant, which has been shown to lower the risk of breast cancer and protect against osteoporosis.\textsuperscript{10} Other phytochemicals in garbanzo beans include isoflavones and protease inhibitors.\textsuperscript{10} A primary macronutrient in garbanzo beans is fiber. Garbanzo beans contain both soluble and insoluble dietary fibers.\textsuperscript{10} Soluble fibers help to rid the body of LDL cholesterol by forming gel-like substances in the digestive tract.\textsuperscript{10} A study performed in hamsters suggests that a diet of garbanzo beans lowers cholesterol.\textsuperscript{11} Garbanzo beans also help to stabilize blood sugar levels and lower Glycemic Index values.\textsuperscript{10} Insoluble fibers help prevent constipation and other digestive problems.\textsuperscript{10} Thus, the abundance of fiber in garbanzo beans helps with dietary tract maintenance and weight loss.\textsuperscript{10}

\textbf{Reference}


<https://hort.purdue.edu/newcrop/CropFactSheets/Chickpea.html>


The Identity, Type, and Structure of Dietary Fiber

The two classifications of dietary fiber are insoluble fiber and soluble fiber. Cellulose is an insoluble fiber that is the major component of cell walls in plants.\(^{12}\) An unbranched linear chain of several thousand glucose units with β-1,4 glucosidic linkages is the chemical structure of cellulose (Scheme 1).\(^{12}\) These linkages create a resistance to biological deterioration, as well as resistance to acid hydrolysis, as the result of hydrogen bonding within microfibrils.\(^{12}\) Furthermore, pectin is classified as a soluble dietary fiber. The prominent component of this complex group of polysaccharides is D-galacturonic acid (Scheme 2).\(^{13}\) Pectin provides structure in most plant cell walls similar to cellulose, but unlike cellulose pectin can be broken down completely by colonic bacteria.\(^{12}\) Additionally, pectin has the ability to gel when polymer molecules interact over a part of their length to form a chain that captures solvent and solute molecules.\(^{14}\) This gelling characteristic is highly dependent on the degree of methoxylated.\(^{13}\) Figure 1 presents the FTIR spectrum of pectin in a chickpea. This data shows a lower absorbance at 1750 cm\(^{-1}\) than at 1650 cm\(^{-1}\) which indicates a low methoxy pectin which is different compared to pectin found in apples.\(^{13}\) Since pectin has a gelling behavior, the rate of gastric emptying may decrease as well as small intestinal transit time.\(^{12}\)

References


Scheme 1. Chemical Structure of Cellulose
Scheme 2. Chemical Structure of Pectin
Figure 1. Fourier-transform infrared spectrum of pectin.
Biosynthesis, Effects of Garbanzo Bean Processing, and the Function of Dietary Fiber

The cell walls of garbanzo beans are mainly composed of dietary fiber. The four major classes of fiber found in cells walls are pectin, cellulose, hemicellulose, and soluble protein (Scheme 3). The plant cell synthesizes these four polymers to build the cell wall. Additionally, specialized enzymes aid in the formation of the polymers found in the cell wall. For example, cellulose is synthesized by the enzyme cellulose synthase. This membrane protein drives the polymerization reaction of glucose from the substrate UDP into the product cellulose. The additional polymers found in the cell wall are biosynthesized by similar routes.

Processing techniques of garbanzo beans cause various chemical changes of their dietary fiber. Milling down a dry Garbanzo bean into a paste decreases the health benefits because the cell walls are no longer intact to inhibit starch hydrolysis which would usually slow down glucose absorption. This effect does not occur when milling down cooked garbanzo beans because the cell walls are still present. In Figure 2, the cell walls of the digested garbanzo beans appear bright indicating some crystallinity in the cell wall compartments. This shows the structure of the cell wall has changed, but it has increased surface area allowing the blocking of reabsorption of glucose and other molecules. Additionally, dehusking and cooking of the garbanzo beans leads to an increase in both pectin and cellulose fibers compared to just removing the husk (Table 1).

Although cellulose is an extremely important type of dietary fiber, pectin has certain chemical properties that have been linked to lowering cholesterol and other fats from the body. Figure 3 shows that the more pectin is available the less free fatty acids are released in the intestinal phase. This removal of fats has been linked to the gelling behavior talked about previously. One proposed mechanism is that SDP (soluble dietary fiber) in gel form creates a
barriers preventing a mixture of bile acid and cholesterol micelles from reaching the intestinal absorptive cells (Scheme 4).\textsuperscript{20} Even though there is much interest in this topic all experimental evidence is suggestive.\textsuperscript{20}

References


(20) Gunness, P.; Gidley, M. Mechanisms underlying the cholesterol-lowering properties of fibre polysaccharides. Food Funct. 2010, 1, 149-155.
Table 1. Changes Of Soluble Protein In Dietary Fiber Components Of Garbanzo Beans

<table>
<thead>
<tr>
<th>Processing Technique</th>
<th>Soluble Protein</th>
<th>Cellulose</th>
<th>Hemi-cellulose</th>
<th>Lignin</th>
<th>Pectin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Grain</td>
<td>2.07 ± 1.06</td>
<td>3.7 ± 1.91</td>
<td>2.7 ± 0.62</td>
<td>2.2 ± 0.65</td>
<td>4.2 ± 1.67</td>
</tr>
<tr>
<td>Dehusked Grain</td>
<td>25.1 ± 0.91</td>
<td>2.9 ± 1.33</td>
<td>1.9 ± 0.47</td>
<td>1.6 ± 0.55</td>
<td>5.3 ± 1.67</td>
</tr>
<tr>
<td>Dehusked &amp; Cooked</td>
<td>26.2 ± 1.15</td>
<td>3.4 ± 1.50</td>
<td>1.6 ± 0.48</td>
<td>2.0 ± 0.64</td>
<td>5.6 ± 1.94</td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>1.8</td>
<td>2.7</td>
<td>0.8</td>
<td>1</td>
<td>3.1</td>
</tr>
</tbody>
</table>
Figure 2. Appearance of cell walls and presence of partially gelatinized starch in cooked pulses (left) and finely diced, cooked pulses after simulated digestion (right) as observed using polarized microscopy.
Figure 3. The influence of pectin concentration on free floating molecules.
Scheme 3. Diagram of Cell Wall
Scheme 4. Entrapment of Bile Salt Cholesterol Micelles in SDF Network

Mixed Bile Salt-Cholesterol Micelles

SDF
Appendix A: Peanut Butter Chocolate Chip Cookies (with Garbanzo Beans)

1 - 15 oz can chickpeas (garbanzo beans) - should be 1 1/2 cups chickpeas
1/2 cup natural peanut butter or any other nut butter
1/4 cup maple syrup (I used Grade B Pure Maple Syrup)
1 teaspoon baking powder
2 teaspoons vanilla
a pinch of salt
1/2 cup chocolate chips

Pre-heat oven to 350. Line a baking sheet with a silicon baking mat or parchment paper.

Drain and rinse your chickpeas. At this point I like to squeeze each chickpea between my fingers to remove the clear "skin" that is on them. It is simple to do but adds an extra 5 to 10 minutes of time. It is completely optional, but I find that taking the skins off makes the batter smoother. This left me with 1 1/2 cups of chickpeas. This is the amount you need.

In a food processor or blender (I tried this in my mini food processor once and it was just too much for it to handle, so use a regular food processor or powerful blender) combine the chickpeas, peanut butter, maple syrup, baking powder, vanilla, and salt. Blend until smooth, scraping down the sides as needed.

Either pulse in your chocolate chips or fold them into the batter. Using slightly damp hands (this helps to keep the batter from sticking) roll batter into ping pong to golf ball sized balls. Try to keep the sizing consistent. Place on your baking sheet. You can squish them down a little bit if you want flatter cookies or keep them as balls. Bake for 10 minutes. They will get a little golden color, but you don't want to overbake them so you aren't looking for a deep golden color. You want them to be moist and gooey.

Enjoy warm or at room temperature! Store in an airtight container on your counter.