Feeling the PULSE of Pea Ingredients

Centara™ Pea Hull Fiber

Delve into Dietary Fiber

Nutri-Pea Limited recognizes that today’s health-conscious consumers want nutritious foods that can help them stay fit and active. However, on average, North Americans consume less than 50% of the dietary fiber levels required for good health. With the preferred food choices of today’s youth, this value may dip as low as 20% — a major factor seen in contributing to the obesity crisis seen in many developed countries. To meet today’s demands, Nutri-Pea has developed an array of highly functional and nutritional pea-based ingredients.

Centara™ Pea Hull Fiber is a unique non-GMO functional food ingredient that can easily encompass today’s trends for nutritious, quick to prepare and easy-to-eat products.

Centara™ Fiber has a bland taste and color that makes it suitable for application in foods ranging from pizza crust and meatballs to chocolate chip cookies and truffles.

What makes Centara™ Fiber a better choice? It combines nutritional and physiological advantages (i.e. dietary fiber enrichment, fat reduction, caloric value reduction, etc.) with technological advantages (i.e. texture improvement, control of moisture migration, reduced weight loss, etc.) in a perfect way.

North Americans consume less than 50% of the dietary fiber levels required for good health and this may be as low as 20% in today’s youth.
The Many Facets of Fiber

Indeed, all fibers are not created equal. About the only similarity among dietary fiber ingredients is that they are carbohydrates. And because fiber can come from a variety of sources, fiber ingredients often contain varying levels of dietary fiber.

Up to now, wheat bran has been the major source of dietary fiber in human nutrition. However, pea hull fiber offers twice the dietary fiber of wheat bran. Delivering more than 90% total dietary fiber, pea hull fiber is one of the richest natural fiber sources on the market.

Due to its neutral and inert properties, as well as the different fiber lengths available, Centara™ Fibers can be used universally in practically any application within the food industry — with no sensory interference.

Centara™ 4 is ideal for white bread and color-sensitive applications.

Major Components of Pea Hull Fiber

Researchers have demonstrated that both soluble and insoluble fiber are important to a healthy diet. Fortunately, Centara™ Fibers delivers both.

Due to their key role in supporting the cell wall’s outer tissues, pea hull fiber contains a particularly high proportion of cellulose and insoluble hemicellulose.

One key technological property of dietary fiber containing cellulose is the construction of a three-dimensional fiber network in the end product, greatly improving the texture and stability of a food.

Even though Centara™ adds primarily insoluble fiber to a formulation, it does add more soluble fiber than some plant sources — due to the 20% pectin that makes up its composition.

Fiber Comparisons

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Total DF (%)</th>
<th>% of which is soluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pectin</td>
<td>90 - 100</td>
<td>90 - 100</td>
</tr>
<tr>
<td>Pea Hull Fiber</td>
<td>88 - 92</td>
<td>15 - 17</td>
</tr>
<tr>
<td>Oat Fiber</td>
<td>85 - 90</td>
<td>1 - 3</td>
</tr>
<tr>
<td>Soy Hull Fiber</td>
<td>70 - 80</td>
<td>18 - 26</td>
</tr>
<tr>
<td>Wheat Bran</td>
<td>44 - 55</td>
<td>2 - 6</td>
</tr>
<tr>
<td>Pea Cell Wall</td>
<td>35 - 45</td>
<td>40 - 50</td>
</tr>
<tr>
<td>Fiber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oat Bran</td>
<td>22 - 26</td>
<td>42 - 50</td>
</tr>
<tr>
<td>Barley Bran</td>
<td>50 - 70</td>
<td>3 - 9</td>
</tr>
</tbody>
</table>

Nutri-Pea Limited offers formulators two pea hull fibers to choose from: Centara™ III and Centara™ IV.

<table>
<thead>
<tr>
<th>Series</th>
<th>Centara™ III</th>
<th>Centara™ IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>• Undergoes a natural process with no chemical modification</td>
<td>• Bright white, ideal for white bread &amp; other color-sensitive applications</td>
</tr>
<tr>
<td>Color</td>
<td>beige</td>
<td>white</td>
</tr>
<tr>
<td>Grind Size</td>
<td>fine, 180 microns</td>
<td>fine, 106-180 microns</td>
</tr>
<tr>
<td>pH</td>
<td>6.5—7.5</td>
<td>6.5—7.5</td>
</tr>
<tr>
<td>Taste</td>
<td>bland</td>
<td>bland</td>
</tr>
<tr>
<td>Total Fiber Content % (db)</td>
<td>90%</td>
<td>93%</td>
</tr>
</tbody>
</table>
Most government and health organizations recommend a daily intake of dietary fiber between 25 to 40 grams. Despite consumer awareness, increased media attention on the importance of fiber, and hundreds of high-fiber products on the market, North Americans are still not consuming fiber in large enough quantities. Average total dietary fiber (TDF) consumption in most developed countries remains at only 10-15 g per day. Many foods intrinsically contain only 1 g of TDF per serving. Even with the inclusion of whole grains, products range between only 1.5g to 2 g of TDF per serving. At these levels, it is not surprising that consumers can not reach national guidelines. As eating habits change to favor foods that contain little or no dietary fiber and as people get less and less exercise, Centara™ Fibers are more important than ever.

Consumers are becoming more attentive to fiber. This means that they will be more likely to notice higher fiber content on food product labels. Consumer perception of “pea fiber” or “pea hull fiber” on an ingredient statement is very positive. Legumes and pulses in general are looked upon as being “healthy”. For fiber fortification of any food, factors such as marketing goals, nutrient claims, costs, and eating quality have to be considered. And food formulators must be aware that there is not a one-stop regulation that fits all countries.

### Reaching for Claims

<table>
<thead>
<tr>
<th><strong>Daily Recommended Value (DRV)</strong></th>
<th><strong>USA</strong></th>
<th><strong>Canada</strong></th>
<th><strong>Europe</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The USDA recommends the consumption of approximately 25g (as much as 38g for males over 19) of dietary fiber per day.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health Canada recommends that Canadians consume approximately 25g (as much as 38g for males over 19) of dietary fiber per day.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Europe, recommended intake varies by country. For example, in France, the DRI is 25-30g; in Germany it is 30g, and in the UK it is 18g.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Labeling Opportunities</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“Good Source of Fiber”</strong></td>
</tr>
<tr>
<td>“Contains”</td>
</tr>
<tr>
<td>“Provides”</td>
</tr>
<tr>
<td>A low-fat food containing greater than 2.5 grams (10% of the DRV) of dietary fiber per serving.</td>
</tr>
<tr>
<td><strong>“Source of Fiber”</strong></td>
</tr>
<tr>
<td>“Contains Fiber”</td>
</tr>
<tr>
<td>“Provides Fiber”</td>
</tr>
<tr>
<td>“Made with Fiber”</td>
</tr>
<tr>
<td>A food containing 2 g of total dietary fiber (TDF) per reference amount and serving of stated size</td>
</tr>
<tr>
<td><strong>“Excellent Source”</strong></td>
</tr>
<tr>
<td>“High in Fiber”</td>
</tr>
<tr>
<td>“Rich in Fiber”</td>
</tr>
<tr>
<td>A low-fat food containing at least 5 grams (20% of the DRV) of fiber per serving.</td>
</tr>
<tr>
<td><strong>“Source of Fiber”</strong></td>
</tr>
<tr>
<td>“High in Fiber”</td>
</tr>
<tr>
<td>A food containing 4 g of total dietary fiber (TDF) per reference amount and serving of stated size</td>
</tr>
<tr>
<td><strong>“Provides ___ % of the Daily Recommended Value of Fiber”</strong></td>
</tr>
<tr>
<td>To maximize the fiber level; Example: if a food contains 10g TDF it can be stated that it “provides 40% of the DRV as it provides 10 g of the 25g DV for TDF”</td>
</tr>
<tr>
<td><strong>“Very High Source”</strong></td>
</tr>
<tr>
<td>“Fiber Rich”</td>
</tr>
<tr>
<td>“Rich in Fiber”</td>
</tr>
<tr>
<td>A food containing 6 g of total dietary fiber (TDF) per reference amount and serving of stated size</td>
</tr>
</tbody>
</table>

Note: In Canada, current fiber claims can be only made on Centara III “unbleached” pea hull fiber. Centara™ IV is currently under review.
Diabetes Prevention

Those with type 2 diabetes or anyone in a pre-diabetic condition can maintain a healthier blood sugar level with higher Centara™ Fiber consumption. Since pea hull fiber does not readily break down into glucose units compared to other carbohydrates, it controls intestinal glucose absorption and assists in stabilizing blood sugar levels.

Danish researchers in 2006 demonstrated that when pea fiber was consumed, blood glucose levels did not rise and fall as rapidly or as severely as they did in response to other food fibers and was superior in its actions even to sugar beet fiber or wheat bran.

Undeniable Health Benefits

Dietary fibers, unlike fat, proteins or carbohydrates are defined according to their physiological characteristics. The biological, chemical and physical properties of dietary fibers are associated with physiological actions in the body’s small and large intestine and have important metabolic implications for health. These properties of fiber include dispersibility in water, bulk, viscosity, adsorption and binding of compounds and fermentability.

Weight Loss Management

A study of more than 74,000 nurses in the U.S. showed that women with the highest dietary fiber intake gained an average of 3.5 lbs less than women with the lowest levels of fiber intake.

The means by which Centara™ can deliver such weight management is as follows:

1. Pea fiber can naturally displace simple carbohydrates and fat, thereby reducing a food’s energy density and overall caloric content.
2. In addition, Centara™ can create a feeling of fullness and satiety. By breaking down more slowly and by absorbing water (and fats) in the intestinal tract and increasing stool bulk, the bulking action of pea fiber assists in filling the intestines and giving one the feeling of fullness and reducing the appetite.

By 2012, over two million Americans and Europeans will suffer from gut health problems. Incorporating fiber into our diet is one of the best things that we can do for our health

Datamonitor 2009

Allergenicity

In 2005, labeling of food allergens became a primetime subject. Fortunately, yellow peas are NOT deemed as a major allergen by FDA or EU governing bodies.

So not only does Centara™ NOT require allergen labeling as necessitated by any of the Big 8 allergens (soy, wheat, milk, peanuts, fish, shellfish, egg, nuts) but also Centara™ can be used as a replacement for wheat and soy fibre in products aimed at allergy sufferers.

By virtue of being gluten-free, Centara™ is also used in products aimed towards consumers suffering with Coeliac disease.

Digestive Health

Today it is known that dietary fiber is required to maintain a functioning digestive system. Through clinical trials, pea hull fiber has been been shown to: increase stool bulk, decrease intestinal transit, promote bowel regularity and prevent constipation. Not only will Centara™ assist in preventing digestive disorders like irritable bowel syndrome and diverticulitis but will also reduce the risk of colon and rectal cancer as well as cancers developing in the small intestine.
Tried, Tested and True

For a fiber to be acceptable for on-going long-term supplementation at a high level, there are several conditions that need to be met:

1. Easy Ingestion @ 15 g daily
2. Good digestive tolerance
3. Maintenance of physiological status
4. Consumer Acceptability

Fortunately, a French study in 2006 demonstrated that 15g of daily and on-going supplementation of a normal diet with pea hull fiber was easy because of acceptable taste and good clinical digestion. Due to its small particle size and fine powdered form it was easy to incorporate into cooked dishes without much notice. Moreover, supplementation with pea fiber showed no modification of colonic motor profiles nor did it result in excessive bloating, flatulence or diarrhea.

Surprisingly, the same can not be said of wheat bran. Studies have shown that diets supplemented with wheat bran are sometimes poorly tolerated, showing bloating and abdominal pain in about 15% of test subjects.

As well, residents suffering from dementia were found reluctant to eat bran-enriched foods confusing it for bugs crawling in their food. Centara™’s light color and neutral taste proved to benefit.

As a result of this study, incorporation of Centara™ Fiber into institutional foods are growing. Obvious options include cold cereals and instant hot cereals in individual packets, fortified soups, breads, muffins and other baked goods, nutrition bars, dairy products and meal-replacement beverages.

Food companies can play a significant role in promoting consumer health by increasing fiber levels in every day foods.

Fiber Supplements

Pea Fiber supplements may provide an uncomplicated and simple way to deliver the nutritional benefits of insoluble and soluble fiber, heart disease and diabetes. A successful fiber supplement might encompass the use of multiple fibers, woven together in formulation to lead them towards better dietary health.

Long-Term Care Home Study

A 10-week Canadian study published in the Journal of the American Dietetic Association, found that substituting Centara™ III for wheat flour in three to four daily menu options in long-term care facilities, significantly relieved constipation, thereby improving the health of residents and potentially reducing their medication expenses.

Fiber intake of people in long-term care institutions is extremely low and as a result, more than 70% of residents are prescribed pharmaceutical laxatives and enemas, costing anywhere from $300 to $1000 per individual a year.

Of the 114 residents who participated in the study, there was an overall increase in bowel movements after menus were enhanced with Centara™ III and most constipated residents showed the greatest improvement after pea hull fiber was introduced.

Also found, was that the use of Centara™ III showed preference over that of wheat bran. Using wheat bran to fortify foods turned foods brown — a color some residents considered "poor man's food", reminding them of what they had to eat during the war when white flour was scarce and costly.

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Further, wheat bran has been shown to impact colonic physiology by decreasing transit time and modifying colonic motility to a point where water and nutrient absorption could be impacted. Also, at high levels of 20-30%, wheat bran imparts a nutty flavor, increases water binding capacity and darkens the color of a product. so significantly that maintaining long-term consumption is not possible or acceptable.
Formulating in Fiber

As far as fiber intake goes, even well-meaning consumers find it difficult to eat all of the recommended vegetables and whole grains required. Consequently, processed snacks and other food products with added fiber have become especially appealing.

Centara™ is ideal for adding fiber to products that are generally low in fiber. Centara™'s unique physical structure and particle size allow for easy incorporation into both liquid and dry formulations. It’s neutral and inert properties are of particular importance for acceptance on the market. Key to successful fiber inclusion is an understanding of the fiber’s properties and how processing might need to be altered.

Market Snapshot

Fiber Ingredient Forecast

According to a 2009 Datamonitor report, one-third of consumers agree that it is worth paying a slight premium for foods with extra nutritional benefits. Consumers agree that fiber is one of the most important nutrients for health. As a result new product introductions with fiber have been increasing steadily over the years. There is good evidence that with rising health care costs, an aging population and concerns about an ever-increasing obesity epidemic, adding fiber to processed foods is the next wave in the North American health and wellness trend.

New Product Introductions in North America with a “High Fiber Claim” (Datamonitor 2009)

Functional-Technological Benefits

- transport & control of liquids through capillary action
- retains 5 times its weight in water
- oil binding in low fat applications
- imparts mouthfeel and body
- texture and structure improvement
- formation of an insoluble 3D fiber network
- promotes softer crumb in baked goods
- allows optimum mixing characteristics and dough relaxation
- encourages anti-caking during sheeting
- minimizes caking / clumping
- synergistic effects with emulsifiers/thickeners

Economical Benefits

- substitution of high priced ingredients
- reduced cooking/frying loss through binding of ingredients
- reduces syneresis and improves frozen stability
- increases microwave stability
- reduces breakage and cracking due to long flexible fibers
- enhances freshness / longer shelf life
- reduced splitting and abrasion
- saving of production times
- encourages high yield
A little bit of Pea Fiber goes a long way

1 tsp = 2.2 g of dietary fiber
1 tbsp = 7.5 g of dietary fiber
1/2 cup = 55.0 g of dietary fiber
1 cup = 107 g of dietary fiber

Food Applications

- Bread Products – 8 to 12% substitution for flour increases volume, improves dough strength, texture, extends shelf life
- Clinical Nutrition / Parenteral Beverages
  Fine particles allow for tubal applications
- Fiber Additive – an excellent substitute for wheat, oat, soy or sugar beet fiber
- Meat Products (sausage, pate, luncheon meat, beef burgers, hot dogs) – texture improver, fat replacer and texture modifier
- Meat Products Filler – is used to replace starch (corn, maize or modified); it is not gritty, it is neutral in color, odor and flavor
- Cookies, Snack Cakes and Muffins – up to 25% substitution for flour, add more liquid ingredients to achieve the best results
- Energy, Health and Wellness bars – a concentrated fiber source for fiber enrichment and fortification; in unbaked cereal bars use 5 to 9%
- Extruded Snacks, Dry Mixes

All Wrapped Up

Wheat flour tortillas are one of the fastest growing segments of the North American baking industry. As this market grows, the search for healthier alternatives to these traditional foods also increases.

In wheat and corn tortillas due to the pea fiber’s water holding capacity, more water can be added to the conventional dough mix — imparting a cost benefit. Test runs have shown that the inclusion of 2% Centara™ III can allow for a 10-15% increase in the level of water used in a corn tortilla formulation.

Due to Centara™’s water absorption properties, processors can deliver a tortilla that is more cohesive and strong while at the same time offering a very noticeable increase in tortilla softness. Not only are tortillas softer but they also retain this softness for a longer period of time. This is a benefit since tortillas are known for going stale very quickly. The softness of the tortilla gives the appearance of freshness. The softness of the tortilla, imparted by the pea hull fiber also improves rollability and prevents cracking.

Nutritionally, flour tortillas are rich in carbohydrates and that generates a high glycemic index subsequent to ingestion — demonstrating a behavior similar to that of white bread. Therefore Centara™ not only can offer fiber enrichment it can also bring down the glycemic index of a tortilla. Retail shelves are now offering consumers tortillas with pea hull fiber at a level as high as 35%. Each tortilla offering 8 grams of fiber per serving compared to 4g in a whole wheat tortillas.
High Fiber Breads

Breads have increasingly become a convenient carrier of dietary fiber. However, the detrimental effect of fiber on dough rheology, loaf volume and bread texture continuously pushes food technologists to look for new sources.

Dietary fiber addition has pronounced effect on dough properties yielding: higher water absorption, mixing tolerance and tenacity, and smaller extensibility in comparison with those doughs made without fiber addition. High levels of fiber also can dilute the gluten content in the flour. Thereby requiring bakers to replace the lost protein with extra wheat gluten in order to avoid a weak dough. Also, because the water absorption is different in high-fiber doughs, typically, more water is needed to get proper mixing and development. Plus, the mixing time may be longer.

Researchers in Spain investigated the effect of several fibers on dough mixing properties. Addition of pea hull fiber to wheat flour (up to a 15% level) produced a very similar bread to the controlled white bread. While the pea fiber addition increased the water absorption, it did so without affecting the dough consistency and stability and it required no extra mixing. Crust color became lighter and more yellow. Even more interesting was that the breads showed improved shelf life due to the reduced tendency of hardening. Overall, Centara™ can be used successfully to obtain a more healthy bread and it can increase the TDF level of a bread from 3 to over 5%.

Adding Centara™ beyond the 5-15% level can be done, however additives may be required to combat the excess water absorption and build up the structure of the bread.

Pasta with Benefits

Adding Centara™ Fiber to pasta is a natural fit. Minimal flavor contribution is a clear advantage when using either Centara™ III or IV in high-fiber pasta.

In large-scale trials, an addition of 7.5% Centara™ III to a standard Semolina formulation, produced pasta that had greater than 8 grams of fiber per 85g serving and passed sensory evaluation.

Manufacturers should be aware that alterations in a standard formulation may need to be made in order to achieve the right moisture balance and pliability. Further, the dough must survive extrusion through the die for an entire production run. Therefore consistency is key.

When fiber is added at a significant level to the raw pasta formulation, processors should note the 3 following factors:

1. The protein content of the formulation will be reduced. Therefore, the manufacturer may have to use additional protein (i.e. gluten) to supplement the formulation in order to support the pasta dough matrix.

2. Secondly, high-fiber pastas tend to cook slightly different from regular pasta. Cooking time may be significantly shorter to achieve the same al dente texture.

3. The amount of water absorbed by high-fiber pastas tend to be significantly more than regular pasta.
Nutri-Pea is the only North American manufacturer dedicated to the wet-processing of yellow peas and hulls into high quality pea hull fiber.

Nutri-Pea Limited is located in Portage la Prairie, Manitoba – in the heart of the Canadian Prairies. Pea Ingredients have been manufactured in this Canadian location for over 20 years. With expertise, Nutri-Pea offers healthy, natural and innovative ingredients for food manufacturers unique applications.

Yellow Pea Hulls: Trusted Origin & Supply

Yellow Peas (*Pisum sativum*) have a history going back some 10,000 years. Originally from the Middle East, yellow peas spread throughout the Mediterranean region and on to India and China.

Although yellow peas have been comparatively underutilized, the tide is turning thanks to recent research showing their remarkable potential in the nutraceutical and functional food markets. Yellow Peas are proving to be a useful source of nutrients in the diet, due to their high levels of protein, starch, fiber, vitamins and minerals and low fat content.

Canada is the world’s largest producer and exporter of NON-GMO peas. Peas are in fact Canada’s largest pulse crop and are grown over a very large geographic area, including significant portions of the provinces of Manitoba, Saskatchewan and Alberta.

Canada being the world’s largest producer of Non-GMO Yellow Peas offers an abundant and ample supply of raw material for Centara™ customers.
While yellow peas are best known for their protein and fiber constituents, they are comparatively a more abundant source of starch

No other single food ingredient compares with STARCH. In terms of sheer versatility of food applications, starch is by far the most consumed carbohydrate in the human diet. It is therefore no surprise that the food industry is one of the largest consumers of starch and starch products in the world. Food starches are derived from a number of sources, the most common being: cereal grains, tubers and legumes. Although yellow peas are best known for their protein and fiber constituents, they are comparatively a more abundant source of starch, comprising 40% to 45% of the dry pea.

Through an innovative wet process, Nutri-Pea Limited produces Accu-Gel™ Pea Starch in conjunction with the manufacture of protein and fiber from peas. This provides a distinct economic advantage over traditionally sourced starches like corn, wheat and potato.

Nutri-Pea recognizes that there is a vast range of specific needs and consumer drivers dictating the food ingredient of choice. Accu-Gel™ Pea Starch helps support the food industry by offering unique functionality applicable to a broad range of food applications. Clearly, understanding the capabilities of Accu-Gel™ and how to exploit its potential will allow food designers to create food products that not only have superior attributes but also meet the latest market trends.
It’s All About the Amylose

Unlike protein, which is made up of different amino acid units, starch has a simple structure: one glucose unit attached to the next. Based on the glucose arrangement, all starches, no matter their source, end up being made of two basic molecules: linear-chain amylose and branched-chain amylopectin. Despite these common building blocks, no two starches are created equal. Each source of starch has its own individual properties and advantages, depending upon their amylose: amylopectin ratio. **Accu-Gel™ Pea Starch** has a relatively high amylose content of 30-35% compared with 20-28% found in most conventional starches. (see Table). Accu-Gel™ offers a unique set of functional characteristics, due in great part to its high amylose content. This in turn creates a unique set of functional characteristics which is promising for food formulators and processors seeking to differentiate their products and solve formulating problems.

<table>
<thead>
<tr>
<th>STARCH</th>
<th>PEA</th>
<th>WHEAT</th>
<th>MAIZE</th>
<th>WAXY MAIZE</th>
<th>POTATO</th>
<th>RICE</th>
<th>TAPIOCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Granule Size (μ)</td>
<td>20</td>
<td>33</td>
<td>15</td>
<td>-</td>
<td>58</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Amylose (%)</td>
<td>35</td>
<td>25</td>
<td>25</td>
<td>&lt;1</td>
<td>20</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Gelatinization Temp.</td>
<td>65-75°C</td>
<td>80-85</td>
<td>62-72°C</td>
<td>63-72°C</td>
<td>59-68°C</td>
<td>68-78°C</td>
<td>59-70°C</td>
</tr>
<tr>
<td>Paste Viscosity</td>
<td>med-low</td>
<td>med-low</td>
<td>medium</td>
<td>high</td>
<td>very</td>
<td>med</td>
<td>high</td>
</tr>
<tr>
<td>Paste Texture</td>
<td>short</td>
<td>short</td>
<td>short</td>
<td>long</td>
<td>long</td>
<td>short</td>
<td>long</td>
</tr>
<tr>
<td>Paste Clarity</td>
<td>low</td>
<td>low</td>
<td>low</td>
<td>high</td>
<td>high</td>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>

Playing it “Hot” and “Cold”

Accu-Gel™ is a “cook-up starch” and therefore requires BOTH a heating and cooling cycle in order to reach its full potential. The minimum temperature required for pea starch to engage its full functionality is defined as its *gelatinization temperature*. Granular starches are insoluble in cold water, but when heated to approximately 140°F to 158°F (60°C to 70°C), the granules begin to swell and gelatinize. As the granules begin to hydrate, they become thicker and more viscous, developing a paste-like texture.

How well a starch reaches its full functionality is determined by how long and how high above the gelatinization temperature it is held. Accu-Gel™ begins to gelatinize at 65°C. Because of its relatively high amylose content, the swelling of pea starch is restricted and therefore the hot viscosity of the starch remains low. This thin viscosity is a useful feature in some food process applications. Viscosity reaches a significantly high value only after cooling. Rapid increase of viscosity occurs to such an extent that it produces a strong, firm and sliceable gel.

Brabender analysis shows that Accu-Gel™ is a LOW-SWELLING STARCH. It does not shown any viscosity peak and maintains a low and stable viscosity during heating.

![Graph showing viscosity changes](image-url)
Ready, Set, GEL!

Accu-Gel™ Pea Starch is considered one of the best unmodified gelling starches in the food market. The gelatinization capacity and viscosity profile of Accu-Gel™ shows comparable performance to that of certain modified cross-linked starches - demonstrating an ability to form very strong, firm and sliceable gels.

At a 5% concentration and cooking at 68°C, Accu-Gel™ forms a gel that is >10x firmer than wheat, corn or potato starch gels. Moreover, at normal cooking temperatures, pea starch can form a gel at usage levels as low as 4%, compared to 10-20% with other starches. When comparing Accu-Gel™ to a common native potato starch on the market, the potato starch required a 25% minimum usage level to attain even a soft gel.

Application Focus: Low Content Meat Products

Accu-Gel™ is particularly effective in low meat content products (i.e. canned meats, reformed meats, vegetarian products and fish products) where a jellified texture is sought after and where sterilization temperatures are applied. In these products, pea starch permits improved water control during sterilization. Canned products made with potato or wheat starch are not stabilized, and consequently absorb more water during storage, contributing to a soggy and softer meat texture.

Accu-Gel™ can be used to reduce the cost or increase the quality of low meat content products: **Case 1**: If a product formulation is limited by texture and color: 5 -10% of mechanically deboned meats (MDM) can be added with 1-1.5% Accu-Gel™. This replaces 5-10% of expensive meats. **Case 2**: If a product is made entirely of MDM, 6-9% MDM can be replaced with 2-3% Accu-Gel™ and 4-6% more water. **Case 3**: Cooked rework levels can be increased by 5-7.5% with the addition of 1-1.5% pea starch.
Application Focus: Asian Noodles

Starch noodles are an important part of Asian cooking and diet. Commonly called cellophane or glass noodles, they are known for their glassy, translucent appearance and are used in soups, stir fries and rolls. The qualities that customers look for in starch noodles are a bland taste and short cooking time. Consumers also prefer noodles that stay firm and unsticky when cooked. To attain these textural standards, the traditional ingredient of choice is mung bean starch. However with the limited world production of mung beans, this becomes an expensive choice. Accu-Gel™ can offer manufacturers a more economical means to produce high-quality starch noodles.

Traditionally, starch noodles are made using a cylinder-type extrusion process. Noodle manufacturers using cylinder-type extrusion can use more economical starches, such as pea starch to partially replace mung bean starch. This will attain consumer acceptable noodle quality with savings. For manufacturers willing to adopt a new method and new equipment, or for those processors that already utilize this technology, high-temperature twin-screw extrusion could prove a simpler and more economical option to make pea starch noodles. The high-temperature twin-screw extrusion process using Accu-Gel™ eliminates two steps in the traditional processing method. The cylinder-type extrusion process requires a portion of the starch to be pregelatinized before extruding the mixture through the die. It also requires that the noodles be cooked in boiling water after being extruded. The twin-screw extrusion process eliminates both of these steps as the pea starch is mixed with water to a moisture content of 30-40% inside the barrel, and the mixture is already cooked (70-100°C; 100-200 rpm) before it is extruded through the die. By eliminating these two steps, manufacturers can streamline their process, make noodles with a superior texture, replace majority of mung bean starch with a more economical starch source, and increase productivity.

All Gelled Up

Accu-Gel’s™ unique gelling properties offer solutions to many food applications:

- Binding in cheese and meat analogues
- Puddings and gelatinized custards
- Texture in canned fish & meat products
- Improvements to soy protein-stabilized food emulsions (i.e. tofu)
- Chewier texture in soft candy products
- Sausages and Reformed Meats
- Hot Fruit Preparations for pectin replacement
- Gelatin replacement for vegan/religious foods
- Stabilization of low fat dairy products (i.e. sour cream, yogurts, frozen desserts)
Extruding Confidence

Temperature and shear conditions in an extruder are extreme. Most starches, especially native ones can not resist such harsh treatment and are completely degraded during the process. Accu-Gel™, because of it’s process tolerance has better ability to withstand extrusion conditions. When utilizing starch for extrusion, the amylose/amylopectin ratio becomes paramount. The amylose content of the starch must be high enough to give enough resistance to the process but also must not be too high otherwise the expansion of the snack will be restricted. With 35% amylose, Accu-Gel™ is close to having the ideal amylose/amylopectin ratio for ideal expansion. Snack formulators incorporating Accu-Gel™ in cheese puffs have demonstrated a higher expansion ratio and a less dense snack than with the use of native potato, corn or even some modified potato starches. This is all done with no impact on production rates or detrimental effects on hardness and cell structure (see Table below).

Processing Proficiency

For starches to function properly in various food applications, the extreme conditions imposed by processing must be tolerated. When it comes to heating, shearing, acidity and retort processes, Accu-Gel™ demonstrates surprising durability, comparable to that of modified starches. All of this is due to Accu-Gel™’s restricted swelling properties. Since, Accu-Gel™ can be heated for one hour at 97°C or undergo pasteurization without damage, the risk of overcooking is totally eliminated. This means over-boiling of sauces and fillings and aseptic processing of meats, soups and sauces do not pose obstacles when using the starch. Accu-Gel™ can also resist an acid environment (pH 3.5) and therefore tolerates various fruit and dairy applications.

Retrogradation: Fear Not!

Accu-Gel™, being a native starch, will undergo retrogradation. During storage, the solubility of the gelatinized molecules decreases, and they begin to crystallize or retrograde. To avoid this and the development of syneresis, pea starches are used in food products where:

1. An increased set-back is beneficial (i.e. in very dry and crispy products). High-amylose starches impart the crispy crunch of snacks and cereals. Because Accu-Gel™ is slow to hydrate, it can extend the bowl life of cereal.
2. In foods that are “Heat and Eat” where there is inadequate time for retrogradation to make an impact. Ball-park cheese sauces and microwave frozen dinners are examples where Accu-Gel™ can be successfully used.
3. In food products where retrogradation is blocked by the interactions with other ingredients. For example, Accu-Gel™ utilized in conjunction with gums, naturally-occurring pectin, or gelatin, successfully restricts syneresis.
Application Focus: Imitation Cheese

Today’s pizzerias and restaurants use increasing amounts of imitation cheese. These imitation cheese products provide flavor and functionality of natural cheese, lowering both calories and cholesterol at a reduced cost. It is normally made by using rennet casein as a primary ingredient, or by using expensive caseinates. Recently, efforts have been made to replace or partially replace rennet because of its variability. When it comes to popular casein and its derivatives, world supply appears to have reached its maximum output. The current high cost and uncertain future availability have pushed processors to find a partial or total caseinate replacement, preferably at lower cost.

Formulations for imitation cheese are complex but Accu-Gel™ can play a role. Since Accu-Gel™ has neutral or no flavor, it does not detract from the cheese flavor. Accu-Gel™ also assists in providing the gelling, binding and emulsion-stabilizing properties required during cheese preparation. Accu-Gel™ Pea Starch has been used as a 15-40% replacement of casein while maintaining desirable textural properties (i.e. gel, re-melt, firmness, stickiness, shredding and slicing characteristics).

Application Focus: Coatings

Processed foods sometimes require help to protect moisture, texture and appearance. Coatings enable food manufacturers to present their products in their intended form. Products that are coated are also becoming increasingly popular as manufacturers are reformulating their mixes to include non-allergenic ingredients, be gluten-free and that can provide improved nutritional value. Because of its high amylose content, Accu-Gel™ demonstrates a unique ability to create thin and strong films when its hot paste is applied in a very thin layer and dried. These thin layers provide the opportunity to form flexible and clear protective layers for snacks, bakery, confectionery, vegetables, meat and fish applications.

Food coatings take a number of different forms and are often used alone or in combination with each other: Predusts are typically sprinkled onto products and function to interface between the substrate and the batter, to optimize batter adherence, contribute to consistent batter coverage and increase batter pick-up. Batters are where foods are covered in its entirety by dipping or being exposed to an overhead flow. Batters enhance flavor, appearance and texture and enable breading to adhere to substrates. Breadings are typically coarse crumbs combined with flavors and colors. They function to increase crispiness and impart a golden color to foods. Glazes are applied to a food via overhead flow or dipping. Glazes act as a protective barrier against dehydration, offers a glossy finish and enhances flavor and color.

Accu-Gel™ has been utilized in a number of demonstrations, illustrating how its film-forming properties contribute to significant technical, functional and sensory advantages when replacing the traditional wheat- or corn-based coatings.

<table>
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<tr>
<th>Product</th>
<th>Outcomes and Benefits of Coatings incorporating Accu-Gel™</th>
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| French Fries (clear coat batter) | • Improved crispiness and reduced softening  
• Overall quality, exterior bite, and baked potato flavor similar to modified cornstarch controls  
• No impact on nutritional composition  
• Increased batter pick-up due to thickened batter  
• No differences in parfrying yield, cooking yield, residual crumb production in the fryer, or freeze-thaw stability |

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“In the case of glazed chicken, Accu-Gel™ and pea fiber performed so effectively that it allowed for the complete removal of gums, allowing for a cost reduction”

<table>
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<tr>
<th>Product</th>
<th>Outcomes and Benefits of Coatings incorporating Accu-Gel™ Pea Starch</th>
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| **Ready to Use Breadcrumbs** (formulated with 42% starch plus 7.3% pea protein) | - Breadcrumbs formulated from rice starch were too dense. While those from corn and potato were the lightest; Accu-Gel™ and tapioca breadcrumbs were considered normal in terms of crumb texture.  
  - Upon frying, breadcrumbs from rice browned excessively and imparted a tough and hard texture.  
  - Tapioca crumbs remained too soft upon frying and did not contribute to the crispiness.  
  - Accu-Gel™-based crumbs had the highest crispiness upon frying. |
| **Microwaved Chicken Cutlets** (Pre-dust w/ 33% Accu-Gel™ and 67% Resistant Dextrin, egg white wash applied; fried @ 195°C, 3 min) | - Accu-Gel™/dextrin coating reduced fat uptake by 30% compared to the control using wheat flour or when dextrin was used alone.  
  - Provided crispier texture even when heated as part of a microwavable meal. |
| **Potato Chips** (formulated with starch/dextrin combination) | - Showed reduced fat absorption compared to a control  
  - Improved crispiness  
  - Better shelf life |
| **Baked Goods** (applied with glaze) | - Glazes delivered an even higher gloss on the baked product  
  - Improved adhesion to the baked good  
  - Discouraged moisture migration from products into the air  
  - Prolonging shelf-life  
  - Because Accu-Gel™ contained no fat, it reduced the calories in the product that would otherwise use oils/fats. |
| **Glazed Chicken Breast** (fully cooked; applied with glaze) | - Less viscous and glossy glaze  
  - Able to thicken at higher usage levels  
  - Increased cook yield (higher glaze pick-up)  
  - Improved freeze-thaws stress |
| **Chicken Nuggets** (ready to cook; applied with predust; tempura batter) | - Significantly crisper and better color development  
  - Improved retention of quality and sensory attributes during extended periods (up to 60 minutes) held under heat-lamps  
  - Equivalent or improved sensory attributes, when compared to control nuggets containing wheat and corn ingredients.  
  - Increased batter viscosity has the potential to replace gums used as thickening agents in the batter. |
| **Fish Nuggets** (ready to cook; applied with predust, batter, breading) | - Improved adherence to surfaces resulting in crispier products containing less oil.  
  - Contributed to freeze-thaw-stability, allowing foods to better survive distribution and transport.  
  - Improved batter adhesion and retention of quality when held under food lamps  
  - Increased cook yield due to increased batter pick up as the coatings adhered more efficiently to the substrate. |
Focus on the “Good” Carbs

Starch is one of the main energy sources in our diet. And in recent years, with food trends based on low-carb theories, starches like all carbohydrates have come under fire as having negative health implications. Pulses, including peas, have long been important components of the human diet due to their content of protein, fiber, and other nutrients. However, more recently, the health benefits of pea starch, beyond just nutrition, have attracted much interest and have helped restore starch to its proper standing as a healthful ingredient.

The digestibility of starch in foods varies widely and is therefore classified as: rapidly digestible starch (RDS), slowly digestible starch (SDS), and resistant starch (RS). In general, the bioavailability of starches from legumes is known to be relatively poor compared to most cereal starches. More specifically, Accu-Gel™ Pea Starch has demonstrated having a lower bioavailability than most other starches both when raw, cooked or retrograded.

Slow and Steady Wins the Race

In its uncooked native form, there are several inherent physico-chemical properties of peas that contribute to Accu-Gel™ being classified as a SDS:

- A high content of viscous soluble dietary fiber constituents,
- The presence of various anti-nutrients (i.e. polyphenols and phytic acid),
- A higher amylose content resulting in higher crystallinity in the starch molecule.

SDS is generally the most desirable form of dietary starch and is completely, but more slowly, digested in the small intestine. This results in diminished blood glucose and insulin levels. Starches, like Accu-Gel™, that promote these slow and moderate responses have a low glycemic index (GI). In recent years, the GI has become a useful tool for planning foods and diets for those suffering with diabetes, dyslipidemia, cardiovascular disease, and certain cancers.

Use of Accu-Gel™ in white bread has been demonstrated to reduce the GI of white bread significantly. Also the metabolic advantages of native pea starch were confirmed in a study of 26 healthy subjects where responses following acute ingestion of pea starch vs modified and unmodified cornstarches were compared. Pea starch elicited less hyperglycaemia (-47%), hyperinsulinaemia (-54%) and C-peptide secretion (-37%) as compared to the cornstarches. Tolerability of pea starch was excellent, opening the possibilities for pea starch to gain prebiotic status and replace cornstarch in industrial food production.

More Amylose = More Resistant Starch

Resistant Starch (RS) has been defined as the fraction of starch that escapes digestion in the small intestine and has functional and nutritional properties in common with dietary fiber.

Most starch, is consumed after various cooking processes, which disrupt the starch granules. After cooking, pea starch, because of its high amylose content, has a higher capacity to retrograde. During retrogradation, recrystallization of the starch molecules occur, leaving the starch more resistant to digestion. Unlike native starch, this resistant starch is not readily digested in the small intestine and instead becomes available for fermentation in the colon. Fermentation is characterized by the production of small-chain fatty acids, especially butyrate, which are believed to affect the metabolism, structure and function of epithelial cells lining the large intestine such that they may prevent several colonic diseases.

Accu-Gel™ is composed of approximately 20-30% of starch resistant to enzymatic hydrolysis in normal conditions of human digestion. When incorporated into noodles, pasta and bread at a 30% level, Accu-Gel™ has demonstrated that it can supply 2g of resistant starch per serving.
Accu-Gel™ offers Clean Label Alternative to Modified Starch

Clean label foods are a major driver for the food industry, as consumers are scrutinizing labels and opting for products that are as natural as can be. Recent consumer research has reported that when surveying consumers of 11 different countries, nearly 73% of consumers said a short, simple ingredient list is important when considering their food and beverage purchases and 61% of consumers were willing to pay more for frozen food with a natural label, which was followed by yogurt (59%), canned soup (58%) and salad dressing (46%).

This opens up a new set of challenges and opportunities for food ingredient companies to find more natural ways of delivering the same functionality in prepared foods as has been provided by additives. This trend also directly influences the starch market as some consumers view the term “food starch modified” negatively. In 2013, more food processors are looking for native starches with the same functionality as modified starches. The answer, of course, is to use native Accu-Gel™ Pea Starch, which is obtained “as is” from yellow peas and refined without chemical modification. Accu-Gel’s™ high amylose content gives the ingredient better thickening, gelling and film-forming properties while having processing tolerance commonly only found in modified food starches. The march to all things natural is likely to persist for some time to come as consumers increasingly buy into the perceived healthiness of the additive-free/natural proposition. Accu-Gel™ provides the solution for the development of the highest quality clean-labeled frozen, baked and refrigerated products without sacrificing product quality and processing performance.

The Taste Factor

Accu-Gel™ Pea starch has a clean bland flavor which is beneficial to delicate flavor profiles. Accu-Gel used in low fat sour cream offered a natural stabilization system for the product while maintaining it’s dairy taste. Some starches can contribute a cereal note when cooked. As such, typically salt is added to mask the flavor. Use of Accu-Gel™ can help reduce the amount of salt.

Market Snapshot

Gluten-Free & Allergen-Free Forecast

Consumer concern regarding gluten and allergens in their food products continue to increase creating a growing opportunity for Accu-Gel™ in the booming gluten-free and allergen-averse market. Findings from a 2012 Packaged Facts report found the market for gluten-free foods and beverages reached 4.2 billion in 2012. 18% of adults buy or consume foods tagged as gluten-free. North American sales of gluten-free food and beverage products are projected to exceed 10 billion by 2017.

With the rise in the popularity of the gluten-free label, it has become increasingly attractive for manufacturers to seek starches from sources other than wheat. Accu-Gel™ demonstrates success in a vast number of gluten-free products. Accu-Gel™ can replace up to 50% of commonly used gluten-free starches and flours. Gluten-free muffins, cookies, and cakes, when replacing rice flour and potato starch with Accu-Gel™, demonstrate notable improvement in texture and softness. Accu-Gel™ becomes the starch of choice in gluten-free breads as there is a significant improvement in loaf color, density and crumb texture. Further, dough and crackers containing pea starch as the base ingredient exhibit good physical properties and acceptable dough quality without requiring additional moisture.
Ten cheddar, drumsticks, fruits, nuts and cheese, sprayed with a plain pea starch coating layer were also demonstrated to be preserved against microbial contamination. This concept of a spray coating, using Accu-Gel™, could also be applied directly on a chicken carcass to prevent cross-contamination of micro-organisms, from carcass to carcass. It could be applied with the inside-outside body washers currently used in the poultry industry.

Using biodegradable plastic for silage bags could be another commercial fit for the product. After the plastic is used, it would degrade in moist soil within a couple of months after disposal.

Researchers at the University of Manitoba have successfully developed a biodegradable plastic using Accu-Gel™ pea starch – replacing the commonly used poly-lactic acid derived from corn. The dried or spray-on wet plastic film has a neutral taste and texture that is able to carry bioactive ingredients without changing its own properties. The wet pea starch gel coating applied directly to the surface of perishable foods also allowed to isolate the food from the environment and to reduce microbial contamination. The starch coating layer contained natural preservatives, natural antibiotics, or natural herbs and spice extracts which are natural anti-microbial agents. Other foods such as sliced chicken, drumsticks, fruits, nuts and cheese, sprayed with a plain pea starch coating layer were also demonstrated to be preserved against microbial contamination.

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Starch-based, plastic-like compostable containers can be made from potato starch, but that product is mechanically weak. Adding pea starch to the mix helps increase its mechanical strength. Accu-Gel™ films are strong, have intermediate stretchability, and good barrier properties at high relative humidity, which make it applicable to intermediate-and high-moisture foods.
Nutri-Pea Limited is located in Portage la Prairie, Manitoba – in the heart of the Canadian Prairies. With expertise, Nutri-Pea offers healthy, natural and innovative ingredients for customers worldwide.

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Yellow Pea: Trusted Origin & Supply

Yellow Peas (*Pisum sativum*) have a history going back some 10,000 years. Originally from the Middle East, yellow peas spread throughout the Mediterranean region and on to India and China.

Although yellow peas have been comparatively under-utilized, the tide is turning thanks to recent research showing their remarkable potential in the nutraceutical and functional food markets. Yellow Peas are proving to be a useful source of nutrients in the diet, due to their high levels of protein, starch, fiber, vitamins and minerals and low fat content.

Canada is the world’s largest producer and exporter of NON-GMO peas. Peas are in fact Canada’s largest pulse crop and are grown over a very large geographical area, including significant portions of the provinces of Manitoba, Saskatchewan and Alberta.

Canada, being the world’s largest producer of Non-GMO Yellow Peas, offers an abundant and ample supply of raw material for Accu-Gel™ customers.