PULSE CANADA

IP INSIGHTS

TECHNICAL UNLOCKS FOR PULSE STARCHES

TABLE OF CONTENTS

TABLE OF CONTENTS

BACKGROUND

The majority of starch used in food and industrial applications is derived from cereal and root/tuber crops including corn, potato and tapioca, but the growth of the pulse fractionation industry in Canada presents a good opportunity to explore potential for pea and other pulse starches. Pulses are unique compared to other starch sources as environmentally sustainable crops. They are extremely effective at reducing greenhouse gas emissions due to their unique ability to sequester nitrogen. Not only do they require little to no nitrogen themselves, they "fix" nitrogen in the soil and help fertilize future crops. Research done by Pulse Canada shows that Canadian pulses are one of the most sustainable crops in the world. Pulses have a very low water footprint, are well-adapted to semi-arid conditions and can tolerate drought stress. They also use water in a different way than other crops grown in rotation, extracting water from a shallower depth, leaving more water deep in the soil for the following year's cereal or oilseed crop.

There are two major categories of pulse fractionation processing: wet fractionation produces a starch isolate (≥85% starch on a dry weight basis) and dry fractionation yields a starch-rich flour (<85% starch on a dry weight basis). Since most of the pulse seed is comprised of starch (~45-48% dry weight basis), this is a significant co-product of pulse protein yielded during the fractionation process. Given the growth in pulse fractionation in Canada over the last decade and the continued investments being made into the industry, significant volumes of pea and pulse starches are available to be used in food, pet food, animal feed, and industrial applications.

PROJECT APPROACH

This project provided Pulse Canada with intellectual property (IP)–derived technical insights and trends to help maximize the use and overall economic benefit of pulse starches. Pulse Canada engaged RTI Innovation Advisors to conduct a comprehensive patent analysis to detail the use of native and modified pulse starch across various industries and applications. Pulse Canada has used the analysis and insights conducted by RTI Innovation Advisors to develop this document.

The aim of this patent analysis is to uncover the industry, application, and technical (e.g., physiochemical properties, functional attributes) trends and insights related to native and modified pulse starches that make them a fit across industries and higher-value applications. This analysis will help guide investment and R&D efforts that will enable producers and processors to maximize the use of pulse starch and the economic benefit of pulse-derived ingredients in the future.

The broad initial search conducted March 2023 returned 10,992 patents and applications filed since 1980, with the majority filed since the late 1990s. The search string employed is provided below. Patents and applications filed in United States (1,036) or China (6,345) are one to two orders of magnitude more common than most other jurisdictions. The top 20 patent filers include several major players from the food & beverage and agriculture industries.

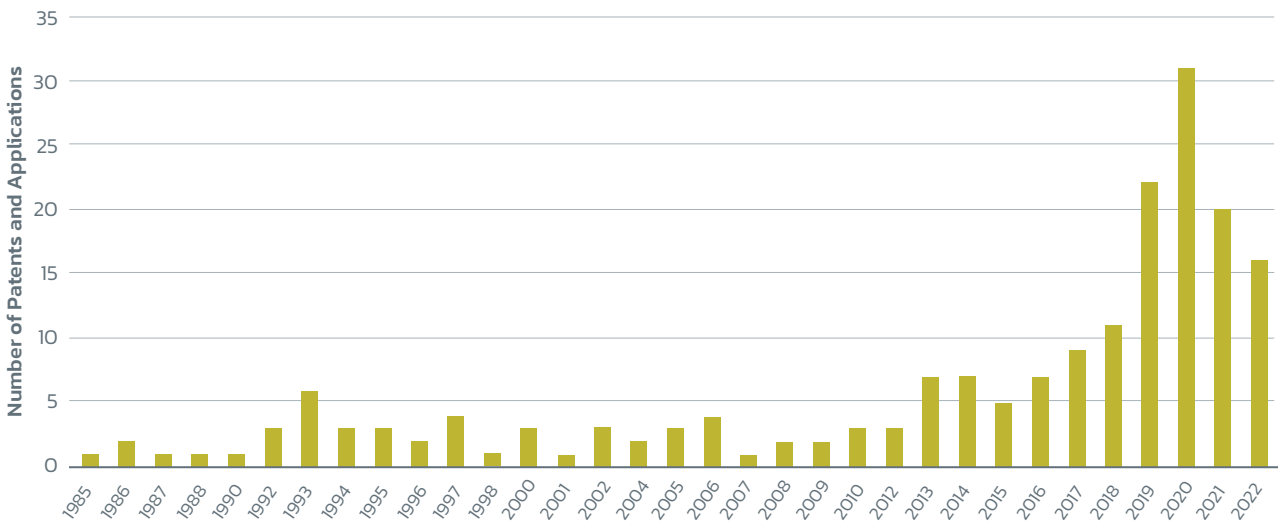
Search String: (@(abstract,claims,title) ("chickpea" OR “garbanzo” OR “ceci” OR “bengal gram” OR “egyptian pea” OR “chana” OR "lentil" OR “dal” OR “masoor” OR “red gram” OR “lens culinaris” OR "pea" OR “mung bean” OR “green gram” OR “golden gram” OR “moong” OR “fava bean” OR “broad bean” OR “horse bean” OR “windsor bean” OR “faba bean” OR “black bean” OR “turtle bean” OR “navy bean” OR “pearl haricot” OR “adzuki bean” OR “azuki” OR “aduki” OR “red mung bean” OR “lima bean” OR “butter bean” OR “sieva bean” OR “madagascar bean” OR “cowpea” OR “black-eyed pea” OR “black eyed pea” OR “southern pea” OR “yardlong bean”) AND ("starch" OR "low-protein flour” OR “low protein flour”))

10,079	Removed applications expired pre-2018
4,792	Removed granted patents issued after 2003 but expired prior to their complete lifetime (20 years)
4,635	Removed all patents with CPC classification codes starting with E, F, G, H and Y
4,625	Removed breeding-related patents: CPC classification codes: A01K 67/'00 and C12N/500 CP
3,833	Removed source jurisdictions: AR (Argentina), BR (Brazil), HK (Hong Kong), JP (Japan), NZ (New Zealand), SG (Singapore), ZA (South Africa), KR (Korea)
3,767	Removed all utility model patents (Kind Codes U or &Y)
3,653	Removed Bayer and BASF patents (e.g., insect inhibitory proteins)
2,555	Removed "cornstarch", "wheat starch", "potato starch", "cassava starch", "arrowroot starch", "tapioca starch", "rice starch"
1,522	Removed "solat*", "fraction*", "separat*", and "extract*"ß
1,375	Removed all patents with pulse proteins that didn't also contain pulse starches in abstract
190	Identified most relevant patents via: reading titles, reading abstracts, and conducting additional key word searching

The full data set of 10,992 patents was strategically filtered as defined above to a set of 190 highly relevant patents for in depth analysis.

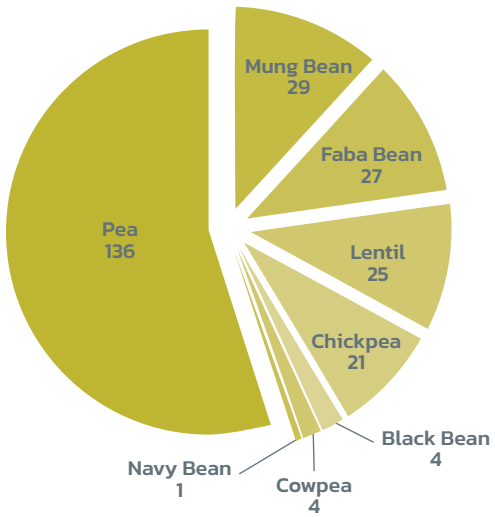
Filtered Patent Set Profile

Patent Activity Over Time



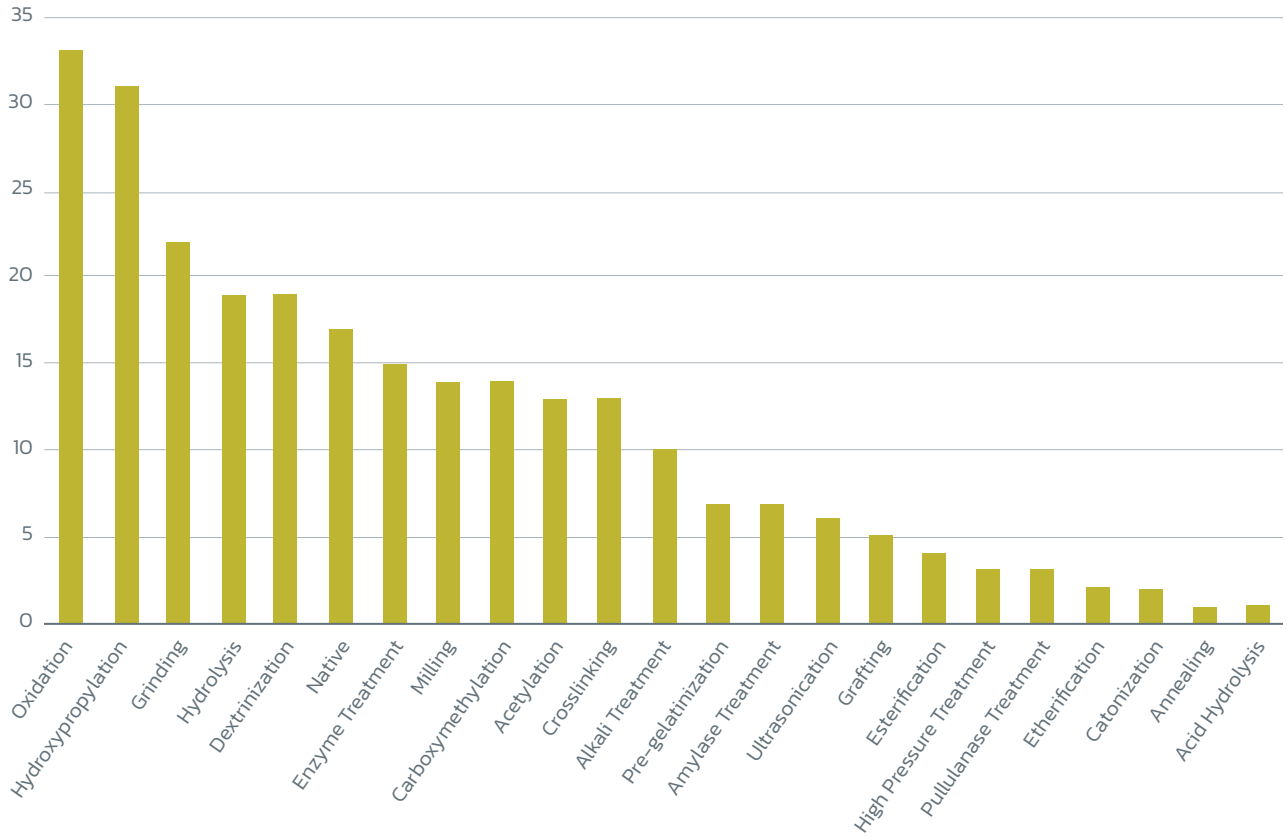
Patent activity (filing and grants) was relatively constant over the period but saw a large increase in the beginning of 2017. Recent and relevant pulse starch–related innovation activity is mainly occurring in China; the United States; and, to a lesser extent, Europe.

Claim Mentions of Pulse Type



Patent and application claims were dominated by the mention of pea starch.

Claim Mentions of Starch Modification Methods



FOOD INDUSTRY APPLICATIONS

Food applications are a desirable end-use market for pulse starches based on the value it provides to pulse ingredient processors; this is reflected in the number of patents filed in this space relative to other industries in the current set analyzed (105/190). However, use in this industry has been limited due to the availability of competitive starch ingredients that have a broad range of starch purity and functionality. The functionality of pulse starch is also widely unique from more common starches making it challenge to use as a direct comparison or replacement. Patent and application claims leveraging the distinct properties of pulse starches have been noted and are described in further detail below.

The most leveraged properties of pulse starches in food across the applications reviewed include their high enzymatic resistance, which contributes to their being slowly digestible, and their strong gelation properties including the ability to form films. Other functional attributes of pulse starches that are leveraged in food application claims include water binding and thickening; properties commonly associated with starch ingredients.

ANALOG PRODUCTS

Beneficial Attributes of Pulse Starch:

- Gelling
- Water Binding
- Thickening
- Texture Enhancing
- Gluten-free
- Plant-based

Native and modified pea starch has been leveraged in the creation of products intended to replace animal-derived foods and/or ingredients. Pea starch is used based on its ability to gel, develop viscosity, hold water, and ultimately contribute to the final texture of products in this space.

Patent Details

ID#	APPLICATION	DETAILS
32	**Bean Curd**	The gel and water holding effect of traditional preparation of konjak bean curd is not ideal. Large amounts of alkali have been added to overcome this but result in off taste and smell. There is a need to improve the preparation method of konjak bean curd. The use of pea starch helps to overcome these problems while improving the hardness, elasticity, chewing property and water holding properties. It has a better toughness, elasticity, and tender texture.
90	**Dairy Substitutes**	Challenges arise in producing a gelling product with increasing viscosity over time, suited for non-dairy substitutes. Extrusion-modified pregelatinized legume starch can form a suitable gelling extrudate.
49	**Egg-Free Albumin**	This invention highlights a desire to create an egg-free albumen product that maintains egg functional properties. Part of the composition contains starch to replace the given functionality but pea starch, or gluten free starch is preferably used.
34	**Vegan Egg**	Pea starch is one of the components used to develop vegan eggs. The patent notes that compared to the use of potato or tapioca starch the use of pea starch and protein when used in formulation made the recipes less elastic and lighter allowing for a greater dough expansion.
104	**Plant-Based Sausage**	This invention creates a vegetarian snack containing pea protein, pea starch, pea fibre, vegetable oil, spices, salt, water and formed into products in a sodium alginate shell hardened with calcium chloride. The production consists of preparing the stuffing, stuffing into casings, thermal treatment, and drying.

BAKED GOODS

Beneficial Attributes of Pulse Starch:

- Gelling
- Thickening
- Solubility
- Texture Enhancing
- Gluten-free
- Low Glycemic Index/ Slowly Digestible
- Source of Resistant Starch/Dietary Fibre
- Sugar/Fat Reduction

The high amylose content of native pulse starches is a unique property that exhibits a slowly digestible nature that can contribute to a low glycemic index product. The high amylose content of pulse starches has also been leveraged in the development of processes to create resistant starch ingredients for bakery. These resistant starches are referenced to improve the overall nutritional quality of products, for example, serving as a reduced calorie flour replacer. Other nutritional benefits of pulse starch utilization in the baked goods category are for its use in cream fillings for pastries with reduced sugar content while maintaining the expected organoleptic quality. Pregelatinized pulse starches have been highlighted specifically in this application based on their cold-water solubility and viscosity development which eliminates the need for cooking. Pregelatinized pulse starches have also been highlighted to improve the overall quality of gluten-free bakery products when used in combination with other ingredients. Specifically noted was the ability of these ingredient combinations to create a honeycomb texture in gluten-free bread and eliminate difficulties in handling gluten-free waffle doughs.

Patent Details

BREAD		
ID#	**APPLICATION**	**DETAILS**
62	**Bread**	Patients with chronic illnesses or diabetes can experience large blood sugar fluctuations after eating typical wheat bread. The invention provides the chickpea starch bread with low GI, which is not only soft and balanced in nutrition, but also strong in satiety and meets the requirements of low GI foods.
57	**Steamed Bread**	With the rise in chronic disease there is a desire to improve the nutritional value of traditional foods, such as steamed bread, commonly consumed in China. One way to do this is to increase the resistant starch content of bread. The high resistant starch composition was made of pea starch, gluten meal, pea fiber powder, oligosaccharide, yeast, and water. The pea starch was obtained through a traditional acid slurry method of production and the starch gelatinized. The use of pea starch improved upon traditional techniques by accelerating starch retrogradation speed, improving the content of resistant starch and maintaining the same quality structure and mouthfeel as traditional bread.
92	**Bread (Gluten-Free)**	This invention produces a gluten-free baking product with characteristics of traditional bread products, including achieving honeycomb structure reminiscent of traditional breadcrumbs. Pregelatinized or precooked native starches in combination with a fiber of plant origin make it possible to create the desired organoleptic characteristics.

Patent Details

OTHER BAKED GOODS		
ID#	**APPLICATION**	**DETAILS**
35	**Reduced Calorie Flour Replacer**	Efforts are being made to limit the use of chemicals used to modify starches. Further resistant starch needs to maintain its resistance after heating during baking. The invention presents a method for developing an enzyme resistant starch from a legume starch where the amylose content is at least 50%.
64	**Cream Filling**	The reduction of the sugar content in food products, while retaining suitable and customary organoleptic properties, and texture, is a major challenge for the food industry. The use of this native starch enables the manufacture of food cream compositions with reduced sugar content using traditional processes, obtaining products with sensory qualities of appearance, taste and texture similar to those of a normal or standard food filling composition.
85	**Pastry Filling**	The purpose of this invention is to create a flavored pastry which can be constituted without the need for cooking (ie adding tap water, cold water, cold milk, etc.). Pregelatinized legume starch is used to confer a bland flavor, good shear stability, good enzyme stability, low lipid concentration, and good cold-water solubility.
65	**Waffle (Gluten-Free)**	The water-holding property, cohesion, and elasticity of gluten-free dough is reduced compared to dough made of wheat flour. The baked product is difficult to form and easy to break. Grease is often used to mitigate that issue. The recipe included in the patent incorporates quinoa powder, tartar, buckwheat powder, and pea starch to improve appearance, texture, taste, and overall quality while also reducing the need to use additional grease in the formulation.

BATTER, BREADING AND COATING SYSTEMS

Beneficial Attributes of Pulse Starch:

- Gelling
- Water Binding
- Thickening
- Texture Enhancing
- Film Formation
- Starch Granule Size
- Crystallinity Development
- Gluten-free
- Sugar/Fat Reduction
- Clean Label

Native and modified pulse starches have been used to improve the final texture of batter, coating, and breading systems. Being high in amylose, pulse starches have a high gelation capacity and the ability to form films which is beneficial to develop and maintain crispiness of coated and/or battered products. Patents leveraging pea starch have made claims related its ability to confer viscosity (eliminating the need hydrocolloids in formulation), provide a less lumpy liquid batter (compared to corn and pre-gel potato starches), and improve the texture by enhancing the water holding capacity of microwaveable or reheated foods. One patent specifically has found the large particle size of pulse starch granules coupled with their retrogradation properties to be advantageous in developing a crystalline structure that can produce a frosted-like appearance, allowing for reduced sugar content in ready-to-eat breakfast cereal coatings.

Patent Details

BATTER, BREADING AND COATING SYSTEMS		
ID#	**APPLICATION**	**DETAILS**
46	**Food Coatings**	It is particularly difficult to keep French fries crisp and golden after cooking even if they are stored in heat due to water migration from the interior of the product to its exterior. It has been found that use of a high molecular weight polysaccharide coating may improve appearance and crispiness after cooking. Amylose rich starches have advantageous film forming properties but are reputed to be difficult to cook. Often these compositions contain complex ingredients including dextrin, flour, and gum. There is a desire to create a simpler solution for coating fried foods to maintain their crispiness. The invention uses a modified legume starch, particularly pea starch, with an amylose content of less than 40% to satisfy the requirements of a simple coating solution. The modification method may include physical, enzymatic, or chemical treatments.
125	**Fried Batter**	This invention provides viscosity and prevents settling in fried batters while eliminating the need for other hydrocolloids such as xanthan gum or guar gum. The patent also aims to improve crispiness in food. This patent describes a method of making hydrocolloid-free batter mix, where the liquid batter comprises pregelatinized pea starch used and described as less lumpy compared to a liquid batter mixture containing corn starch or pregelatinized potato starch.
108	**Breading (Gluten-Free)**	This invention describes a breading precursor composed of legumes in a pre-dried and granulated state, where cooking is done by exposing the dry ingredient to high temperature and moisture. The binder is formed by pre-gelatinizing leguminous starch.
30	**Microwave Cookable or Reheatable**	Many microwavable foods become soggy and thus detract from the texture and taste of the product. Pea or wrinkled pea starch is used as part of the batter to improve water holding capacity.
106	**Sugar Coatings (RTE Breakfast Cereal)**	This invention intends to replace part of the sucrose contained in the syrup used for coating ready-to-eat breakfast cereals and/or reduce sugar content (specifically monosaccharide and disaccharide content) of cereals. The present invention relates to a process for coating and glazing breakfast cereals in which sugars, in particular sucrose, are replaced pregelatinized starches rich in large particle size amylose with soluble fibers. The retrogradation properties of amylose can be used to meet the required crystallinity criterion. Additionally, the large particle size of the amylose-rich pre-gel starch contributes more effectively to the frosted appearance of the coating.

BEVERAGES

Beneficial Attributes of Pulse Starch:

- Low Glycemic Index/ Slowly Digestible
- Source of Resistant Starch/Dietary Fibre

Some innovative application claims have been made related to the use of pulse starches in beverage applications. The development of more nutritious, fibre-rich beverages has been presented by combining pulse starches with oats or processing to produce resistance starches that serve to reduce sugar content or slow carbohydrate absorption, respectively. One patent details a mixture of pea starch with other ingredients as a pre-treatment which allows for the elimination of wet processing of the coffee beans following decortication.

Patent Details

ID#	APPLICATION	DETAILS
36	**Infant Formula**	It is recognized that suboptimal feeding during critical periods of development may alter organ development to predispose humans to chronic disease later in life. Specifically, this invention suggests high carbohydrate diets may be problematic for metabolic syndrome disorders later in life. Replacing starch with resistant starch is a means of decreasing carbohydrate absorption within the body. Legume starch is one of the types of resistant starch recommended in this invention for use in infant nutrition formulations.
37	**Soluble Fibre-Rich Beverage**	There is a desire to reduce sugar consumption among consumers to reduce obesity and diabetes as well as dental caries. This invention presents a method of developing a pulse and grain composite beverage. The idea is that this mixture is incorporated into a convenient, portable product that contains the needed amount of soluble fiber for making health claims. Combining pulse starches (which contain soluble fiber) with the traditional oats is one method that may improve the ease, time, and expense of development.
60	**Wine**	Current chrysanthemum wine often has a heavy wine yeast taste with bad flavor so there is a desire to improve the quality, yield, and antioxidant performance of the wine by adding a superoxide dismutase. This invention uses pea starch in the composition of the superoxide dismutase wine; however, it is not clear why pea starch is used based on the details provided.
69	**Coffee**	After decortication process, the coffee bean is surrounded by a pectic substance which hinders the rate of drying of the coffee bean and influences the quality of the final product. A mixture of pea starch, glutinous rice, and white sugar is used as pre-treatment for the coffee beans. This is meant to replace traditional wet processing of coffee beans.

CONFECTIONARY AND DESSERTS

Beneficial Attributes of Pulse Starch:

- Gelling
- Water Binding
- Thickening
- Texture Enhancing

The strong gelation properties of pulse starches are leveraged in gels and puddings, providing a desirable texture and mouthfeel after modifications have been applied and/or when used in combinations with corn starch.

Patent Details

ID#	APPLICATION	DETAILS
68	**Gels**	Starch causes a loss of clarity of the gel and an intense stickiness in the mouth, and it imposes very high firing temperatures. These issues were alleviated using fluidized and stabilized leguminous starch with an amylose content of between 25 and 40%.
113	**Puddings**	There is a need for improving the syneresis stability of gels based on pea starch, such as of cooked puddings, while the lower starch concentration as compared to corn starch as well as the smooth, flan-like texture should be maintained. It t has been found that these advantageous properties of pea starch are maintained, while the disadvantageous properties thereof are simultaneously eliminated when pea starch is used in a mixture with corn starch.

DAIRY PRODUCTS

Beneficial Attributes of Pulse Starch:

- Gelling
- Water Binding
- Thickening
- Texture Enhancing
- Source of Resistant Starch/Dietary Fibre
- Clean Label

Pulse starches and starch–lipid complexes have been described in patents as a nutritious alternative to texturizing agents used in yogurt and cheese processing, likely contributing to viscosity development in these products.

Patent Details

ID#	APPLICATION	DETAILS
66	**Yogurt**	Slowly digestible starch food in the market has an undesirable taste, insufficient nutrition and is difficult to meet the requirements of consumers at present. A yogurt beverage was developed which contains a starch–lipid compound, containing mung bean starch.
67	**Cheese**	Cheese-based foods do not always guarantee a balanced nutrient supply. Pea starch and vegetable fibers can be used as alternatives to undesirable ingredients, acting as texturizing ingredients in cheese-based food preparations.

MEAT PRODUCTS

Beneficial Attributes of Pulse Starch:

- Water Binding
- Solubility

Pulse starches have been leveraged in the creation of meat products such as sausages, pork tripe and dried meat floss, presumably serving as a binder in formulation. One patent specifically calls out the ability of esterified pea starch to alleviate phase separation in sausage production when used as a thickening agent.

Patent Details

ID#	APPLICATION	DETAILS
40	**Sausages**	During sausage production, when the sausage mixture does not thicken, it can lead to phase separation, oil and water separation and inelastic properties. Starch is found to help improve these deficiencies, but still has problems sometimes including limited water holding capacity, poor taste/flavor, and excessive amounts of starch needed. Pea starch denaturation through organic acid esterification is used as part of the proposed composition for the sausage thickener.
89	**Sausages**	Preparing a truffle sausage recipe including lean pork, vegetable oil, freeze-dried truffle, soy sauce, glucose, salt, white spirit, mung bean starch, egg white, and white pepper powder.
123	**Pork Tripe**	Thie invention details a method to create a flavourful and nutritious tripe in which mung bean starch is added in a slurry to the pork tripe, along with additional seasonings including soy sauce and sesame.
87	**Dried Meat Floss**	This invention creates bamboo shoot dried meat floss which has characteristics of high protein, high dietary fiber, and low fat that meets consumers' nutritional requirements. Bamboo shoots dietary fiber, dried meat floss (semi-finished product), pea starch, edible oil, and seasoning are combined to create the desired product.

NOODLES AND PASTA

Beneficial Attributes of Pulse Starch:

- Gelling
- Film-formation
- Gluten-free
- Low Glycemic Index/ Slowly Digestible

The most widely adopted food application of pulse starches is in the production of glass noodles, vermicelli noodles and bean jelly sheets because of their ability to form strong gels. It follows that most patents using pulse starches in pasta and noodles applications are related to such products. Historically, mung bean starch is used by this industry, however, pea starch has gained prominence as a cheaper alternative while maintaining the desired textural properties. While these products are typically made using pulse starches as the main component, some patents have developed formulations of pasta and noodles using pulse starches in combination with other ingredients such as rice, buckwheat, durum, sweet potato, corn, and more. One patent describes a combination of black bean starch and sesbania gum which is used to help reduce breaking and cooking losses in brown rice vermicelli with improved taste. Others have also noted the success of pulse starches (notably pea) in reducing the rate of noodle breakage. Acetylated pea starch specifically has been leveraged in noodle production with the advantage of providing the desired texture and elasticity while reducing issues with stickiness, such is the case with egg white replacement.

Patent Details

VERMICELLI	
ID#	**DETAILS**
51	Rice vermicelli is a staple food in China, but its production is hindered by the excessive coarse fibers and rich unsaturated fat content that deteriorates in heat leading to poor smell and rough taste which is adverse to many consumers. The quality of brown rice vermicelli is improved by use of sesbania gum and black bean starch in comparison to corn, potato modified, or cassava modified starch. It improved taste, strip breaking rate and cooking loss rate.
59	Vermicelli is a common food in China but often is eaten in excess leading to obesity. There is a desire to create a vermicelli that has improved health properties and low cost. In the composition of the konjak vermicelli pea starch is used. Pea starch is mixed with konjak powder and noted to avoid the vermicelli sticking and improve the finished product rate of processing. Pea starch is also noted as a healthy ingredient – improving immunity and preventing cancer.
73	Broad bean starch is added to the recipe to achieve the desired effects of improved nutritive value, color, and taste of bean vermicelli noodles.
91	This invention develops corn-based noodles with golden outward appearance, neutral flavor, flexible texture, and easy digestion. A recipe containing maize pulp, mung bean starch, and edible salt is processed to achieve the desired result.
98	This invention creates a vermicelli noodle that has a higher nutritive value than what is most commonly found on the market (white bean vermicelli). Mung bean starch is produced through purification, immersion, pulverisation, filtering, and mixing. The starch is then added to yeast, water, and bryophyte powder to create the noodles.
71	Lowering the breaking rate of vermicelli noodles when boiling can be challenging. A mixture of pea starch, dextran, calcium chloride, shellac wax, sodium alginate, polyvinal wax, citric acid, and potassium aluminum sulfate can lower the rate of breakage by 90% and increase by double the boiling resistance of the noodles.
74	Low product quality of vermicelli noodles can result as there is often mildew when the product is sold to international markets, resulting in waste. Pea starch provides a desirable texture that is not easily broken and ensures constant product quality with low chance of molding.

GLASS NOODLES	
ID#	**DETAILS**
76	There are some challenges in maintaining firm and non-sticky texture of noodles during the short cooking time. Mung bean is typically used, but it could be expensive. Pea starch is a cheaper alternative that achieves the desired properties.
78	Low cross-linked pea starch is a cheaper alternative than mung bean starch that achieves the desired textural properties. It also has a higher gelatinized temperature compared to native pea starch (2 °C increase).
79	Low stability pea starch is able to achieve the desired texture for glass noodle production.
80	The purpose of this invention is to replace mung bean starch with a similar but more economical alternative. Low-cross-linked pea starch (particularly low acylated pea starch) achieves the desired texture for glass noodle production.

JELLY SHEET	
ID#	**DETAILS**
33	There is a desire to incorporate Cortex Eucommiae into a bean sheet jelly. Mung bean wet starch is used to make a bean sheet jelly comprising traditional Chinese medicine ingredients. Mung bean is also suggested to have health properties.
96	This invention creates a health food comprised of cactus and mung bean starch. Starch is extracted from mung bean and is used to achieve the desired texture and nutritive value of the product.
99	This invention develops a new technology for producing edible ultra-thin sheet jelly made from pure mung bean. The production method involved mixing water with green gram starch, heating while mixing constantly at 100 °C, and pouring the slurry onto an elongated plate glass. The sheet is cooled off for 5 minutes and baked for 10 to 15 minutes at 140 °C.
126	Developing a cold jelly manufacturing method that ensures nutritional value and improved taste. The gel is produced by taking market fish paste, adding salt, chopping, and mixing to obtain mixture, then adding protease and putting the mixture in a water bath for enzymatic hydrolysis. The mixture is heated to inactivate the enzymes and de-ionized water and pea starch are combined and added into the initial mixture. The final mixture is heated then cooled to achieve the final product. The addition of pea starch ensures proper forming of the gel.

Patent Details

NOODLES AND PASTA	
ID#	**DETAILS**
95	This invention creates a preparation method for noodles comprised of pure pea starch.
102	Preparing food products from the seeds of the Chu tree and Kuzhu tree. Starch is derived from the seeds and stirred in with sour pea or mung bean milk for added starch. The final product can be used as an ingredient in noodles.
83	Typical egg white replacement (using potato or tapioca starch) results in sticky texture in noodles, which prevents them from drying properly. Acetylated pea starch is a more suitable replacement for egg proteins, they achieve the desired texture and elasticity.
75	Producing a low GI buckwheat cold noodle that can be easily extruded into noodle shapes can be challenging. Buckwheat flour and mung bean starch are used in a 3:2 ration to achieve the desired texture.
31	Many people are taking caution to selecting foods with high starch content so there is a desire to create hot and sour rice noodles with a lower starch content. Hot and Sour Rice Noodles were prepared using sweet potato starch, pea starch, and other ingredients.
82	Prepared rice noodles are not convenient to carry and have a limited shelf life (16 hours at room temperature). A self-heating preparation composed of a liquid bag (water, pea starch, vegetable fat flour) and powder bag rice powder, pea starch) is created to mitigate the issue.
43	Instant noodles are increasing in popularity while the desire to generate high fiber foods is also increasing. However, to achieve a desirable noodle texture, wheat flour is often replaced by starch. Modified starches are often used due to their higher stability under temperature, pH, shear, and refrigeration. The solution to date has been to use acylated potato or tapioca starch but the problem is that the noodles present a sticky surface. This patent details the use of an acetylated pea starch to mitigate the issues associated with stickiness related to the use of acetylated potato starch.
61	Producing pasta of high biological value and low cost. The pasta composition includes high amylose pea starch containing 60% amylose, in an amount of 5-20% by weight of flour.

RTE MEALS

Beneficial Attributes of Pulse Starch:

- Solubility

One patent has proposed a method to reduce the loss of texture associated with retrogradation of amylose in instant porridge style products produced from mung bean starch. Both low temperatures and sugar (decreased free water content) are used to reduce the arrangement of amylose in the system.

Patent Details

ID#	APPLICATION	DETAILS
114	**Instant Porridge**	The main challenge with instant porridge is the pasty quality of the product after being mixed, and the granularity, chewiness, and hardness of traditional porridge product is lost. The invention aims to provide a production method for improving the edible quality of mung bean instant porridge and to reduce starch aging. The described method results in reduced free water content due to the presence of sugar preventing the sequential retrogradation of amylose. The mixture is also frozen at extremely low temperatures (-80 °C), to reduce ordered arrangement of amylose when the amylose and also prevent its retrogradation.

SAUCES, SOUPS, SALAD DRESSINGS AND SPREADS

Beneficial Attributes of Pulse Starch:

- Water Binding
- Thickening
- Solubility
- Texture Enhancing
- Emulsifier
- Mild Taste and Colour
- Stability Under High Oxidative, Temperature and Shear Conditions
- Source of Resistant Starch/Dietary Fibre
- Sugar/Fat Reduction

Pulse starches have been leveraged in many sauce and soup style applications based on their ability to confer the desired texture, rheological properties, and appearance of these products. The use of pulse starches, specifically due to their high amylose content, has been found advantageous in the production of a dried powder intended to provide a mushy or pulpy texture when reconstituted into a sauce. This is relevant for many applications including tomato sauce, apple sauce, juice, vegetable soup, and more. Pregelatinized legume starch specially is claimed to provide a clear appearance, while remaining stable under shear, proving useful in savory concentrate applications such as broths, bouillons, soups, and gravies. Other patent and application claims leverage pulse starches for their ability to improve the nutrition of products, such is the case in a reduced fat peanut butter spread in which chickpea starch maintains a low water activity without adversely affecting the texture. The use of resistance starch produced from pea has also been employed to improve the nutritional value of salad dressing while maintaining emulsion stability.

Patent Details

SAUCES		
ID#	**APPLICATION**	**DETAILS**
47	**Powdered Instant Tomato Sauce**	Though amylopectin rich composition has been thought to improve the texture of pasty foods through strengthening and stabilizing a pulpy structure, it has also been found that they can disrupt the molecular structure of the starch and thus should be avoided. Pre-gelatinized, high amylose starch with a coarse particle size has instead been found to be advantageous for use as a texturizing agent to confer a pulpy character to pasty food compositions. Preferably the starch is from legumes, particularly field beans or peas and has an amylose content between 25-45%.
56	**Reconstituted Pulpy Sauce (i.e apple, tomato)**	Reconstituted products typically have a homogenous and smooth structure which is typically desirable and achieved through use of starch. However, in some cases a pulpier texture is desired (apple sauce or tomato sauce) which is more difficult to achieve from a dry product. A pregelatinized legume starch that has a maximum amylose content of about 50% rehydrates in liquid to form a pulpy textured paste rather than a smooth starch sol or gel which is advantageous for these reconstituted products with a desired pulpy texture.
72	**Reconstituted Mushy Sauce (i.e fruit sauce, soup, juice, compote, concasse, vegetable soup)**	Achieving a smooth, creamy texture when reconstituting a dry food product can be challenging. It has been found that the addition of pre-gelatinized pea starch to dry food composition achieves the desired composition when the food is reconstituted.
101	**Reconstituted Pulpy Sauce (i.e tomato sauce, apple sauce, apple compote or "potage")**	Dry food contains pre-gelatinized starched derived from legumes such as peas, beans, lentils, which may be partially in the form of a starch sponge. The pulpy texture can be achieved by roll-drying a suspension of native leguminous starch. This allows for more rapid reconstitution in cold aqueous liquid.

Patent Details

SOUPS, SALAD DRESSINGS AND SPREADS		
ID#	**APPLICATION**	**DETAILS**
54	**Savory Concentrate for Broths, Bouillons, Soups, Sauces, Gravies, etc.**	Consumers are increasingly aware of artificially looking foods such as concentrates and gels and are seeking clean labels. There is a desire to meet consumer demand while providing savory concentrates that are visually appealing. Gelatinized, legume starch provides a liquid, savory concentrate that is clear at ambient temperature but remains stable after shear is applied. Preferably, the amylose content is greater than 25% and the ratio of gelatinized starch to total starch is at least 0.5.
53	**Peanut Butter**	Reduced fat peanut butter often results in a product with lack of flavor and poor texture and consistency. Garbanzo bean starch in native form is used for developing a reduced fat peanut butter product by replacement of fat and/or sugar. Garbanzo bean starch has oil and water binding properties and aids maintaining low water activity without adversely affecting the texture.
52	**Salad Dressing**	The healthfulness of salad dressing is a consumer concern and stability of salad dressing must be ensured without the use of unhealthful ingredients. Pea resistant starch is used in the development of a healthier salad dressing in this patent to improve the stability of the oil in water emulsion and improve the rheological and organoleptic properties of the salad dressing. Further, the starch improves the nutritional value of the dressing.

SNACKS

Beneficial Attributes of Pulse Starch:

- Texture Enhancing
- Gluten-free
- Mild Taste and Colour

Pulse starches have been leveraged in extruded snacks as a key component of the base formulation because of their expansive properties. One patent specifically prefers pulse starches for their ability to provide a crisp final product texture with low adhesion in the mouth upon chewing and a decreased astringency flavour. One other claim has leveraged pea starch in the production of fried sweet potato chips.

Patent Details

ID#	APPLICATION	DETAILS
63	**Sweet Potato Chips**	Long-term preservation of fried purple sweet potato chips is difficult. This invention created dough out of sweet potato flour, pea starch powdered sugar, butter, and water. The mixture is quickly cooled and frozen to preserve the chips.
109	**Puffed Snack**	The patent describes a process for the manufacture of an expand, wavy stick-type starch product to mitigate the production cost associated with producing puffed starch-based snacks by adjustments to the extruder method and adding the intended surface pattern after extrusion.
115	**Extruded Starch**	This invention presents a for producing a starch-containing product suited for extrusion heat conditioning which does not easily disintegrate in shape, has a high matte feeling, and is excellent in appearance.
118	**Puffed Snack**	This invention developed a puffed food product containing preferably pulse starch having a crispy texture which does not adhere to the teeth and suppressed astringency.

FOOD PIGMENT AND ORGANIC COMPOUND PRESERVATION

Beneficial Attributes of Pulse Starch:

- Solubility
- Film-formation
- Retention Capacity
- Encapsulation Agent
- Mild Taste and Colour
- Stability Under High Oxidative, Temperature and Shear Conditions
- Low Glycemix Index/ Slowly Digestible

Patent and application claims have used native and modified pulse starches to successfully preserve and/or mask colour pigments, aromatic, volatile and other organic compounds during the cooking and storage of foods. This is achieved through complexing with, or the retention of, the compounds themselves. Other processes have specifically leveraged the film-forming properties of modified pulse starches in the development of encapsulation agents. In these applications, the use of slowly digestible pulse starches allows for a controlled rate of release, producing films with good solubility and high oxidative and temperature stabilities.

Patent Details

FOOD PIGMENT AND ORGANIC COMPOUND PRESERVATION		
ID#	**APPLICATION**	**DETAILS**
130	**Color Stabilizer**	Most colorants add no nutritional value to the food product. When natural dyes are utilized, they often have issues regarding stability which is why they are often recommended to be kept out of light. Depending on consumer compliance, this may or may not be effective. Some have proposed solutions to stabilize these compounds by complexing them to hydrocolloids. Hydroxypropylated starch has been found to stabilize natural dyes and be easy to use. The starch is derived from pea or corn and preferably smooth pea starch with an amylose content between 35–38%.
55	**Wine Aroma Powder**	In alcoholic products the aromatic compounds are readily volatile. When used in cooking preparations these volatiles readily escape and do not always retain the desired flavor. There have been several attempts to produce aroma powders from alcohol containing liquids, but these products have high hygroscopicity and only slight aromatic stability. There is a desire to develop an aroma powder, wine powder, that can be added to foods and provide the same impression as the addition of the underlying alcohol containing liquid while having as little taste of its own. Native pea starch and acid modified pea starch have been found to have an outstanding retention capacity for aromatic substances and very low retention capacity for alcohol by comparison to traditional starches.
41	**Maltodextrin/ Glucose Syrups for Volatile Compound Encapsulation**	Volatile compounds must be packaged appropriately to preserve them. Encapsulation and micro-encapsulation techniques are often used. It has been found that encapsulation of volatiles with greater hydrolysis is more effective. Amylose, due to its ability to form inclusion complexes, is also sometimes used but has a propensity for crystallization and retrogradation and thus must be carried out at high temperatures. Stabilization reduces the temperature needed for encapsulation but also their ability to form inclusion complexes. Acid hydrolysis of legume starch with 25–50% amylose content was used to generate maltodextrins and glucose syrups for encapsulation purposes. Pea starch has been found to particularly be a great encapsulation agent for hydrophobic starches and have better protection against oxidative damage than other starches.
133	**Film Forming Coating**	Film forming coatings protect the active ingredients from the environment, modify rate of release, mask taste, protect color. Ideally, the film forming agent allows for an elastic and cohesive film. These films, however, often crack and need a plasticizer. This invention sought to find an ideal starch plasticizer composition that required less plasticizer, particularly sorbitol, than other compositions.

Patent Details

FOOD PIGMENT AND ORGANIC COMPOUND PRESERVATION (CONTINUED)		
ID#	**APPLICATION**	**DETAILS**
134	**Film Forming Coating**	Identification of a starch plasticizer pair allows for the film forming composition to overcome the challenges associated with prior art. Hydroxypropyl pea starch, preferably smooth pea starch is used as a film forming agent and has an amylose content between 35–38%.
147	**Encapsulation, Inclusion, Entrapment of Organic Compounds**	Cyclodextrins are often used for encapsulation but are highly regulated, high amylose starches have been considered as an alternative but require very strict conditions for preparation and use and retrograde rapidly. Maltodextrin is desired as an alternative to cyclodextrins and amylose rich starches for encapsulation. Maltodextrin resulting from a high amylose, preferably 25–50%, starch was found to obtain a product that is very stable to high temperatures, has good solubilizing properties and high stability. Cross-linking of the maltodextrin from amylose rich starch with a compound having an electropositive carbon atom was the method used. The starch is chosen from legume plants.

FUNCTIONAL FOOD ADDITIVES

Beneficial Attributes of Pulse Starch:

- Gelling
- Water Binding
- Thickening
- Emulsifier
- Foaming Agent
- Source of Starch-Lipid Complex
- Clean Label

Many modifications have been patented which enhance a specific functional trait of pulse starches intended to be used in foods. For example, starch-lipid complexes that are obtained using hydrothermal treatments have been demonstrated to function as emulsifying agents. The combination of pulse starch with albumin proteins has also been leveraged to create oil-in-water emulsions or to develop highly stable foaming properties. Other modification techniques such as cross linking or pregelatinizion may enhance the native thickening and gelation properties of pulse starch and allow them to be used as additives for such in foods. One patent details a cooking and sonication process which helps to alleviate some of the retrogradation and syneresis challenges associated with pulse starch utilization in foods.

Patent Details

ID#	APPLICATION	DETAILS
127	**Emulsifier**	In situ synthesis of starch and lipid complexes have been demonstrated during heat moisture treatments. Both show a decrease in amylose solubility and an increase in gelatinization temperatures. This patent seeks to detail the methods of making such a complex for emulsification applications. Amylose is known to complex iodine, alcohols and particularly lipids. Formation of starch-lipid complexes has benefits to reducing stickiness, improving freeze thaw stability, and retarding retrogradation. This invention details the method of preparing such starch-emulsifier. Note a variety of sources extending beyond legumes are used, such as corn, but must be high amylose.
102	**Oil-in-water Emulsions (Cream, Soup, Sauces, Dips, Desserts, Drinks)**	This invention produces a stable oil-in-water emulsion of neutral pH, smooth texture, and high heat stability. The desired emulsion can be achieved using gelatinized starch, pulse seed albumin, and a non-starch polysaccharide of a low charge density. The gelatinized starch provides water structuring properties, and the pulse seed albumin provides emulsifying properties.

Patent Details

FUNCTIONAL FOOD ADDITIVES (CONTINUED)		
ID#	**APPLICATION**	**DETAILS**
70	**Foaming Agent**	Producing a stable foam from a plant-based protein isolate is challenging. High concentrations of lentil albumin, lentil starch combined with low triglyceride content contributed to excellent foaming properties of the lentil foaming agent.
128	**Gelling Agent**	Concentrated food products have been used for years but recent unnatural perception often due to the gelling agents is causing food companies to find new alternatives. Legume starch is used as an alternative to other gelling agents that consumers perceive as unhealthy. Notably, legume starch is not chemically modified but may be physically modified e.g., pregelatinized.
86	**Thickening (i.e Egg White Substitution)**	This invention provides a method for improving food texture, quality and the like in various kinds of processed foods (meat processed food, processed marine products, bakery foods, chilled dessert, noodles, etc.). A composition containing a thickening polysaccharide and one or two kinds of starch selected from one group consisting of phosphoric acid cross-linked pulse starch.
42	**Maltodextrin Replacement**	Native starch is not soluble in water, easily retrogrades resulting in syneresis. Modification can improve these deficiencies but due to clean label demands, there is an increasing interest in physical modification methods that result in the same function benefits as chemical and enzymatic methods. This invention details the use of a physical modification process to develop a highly soluble leguminous starch that consist of cooking the starch water mixture and then sonicating it.

RESISTANT STARCH/STARCH-LIPID COMPLEX DEVELOPMENT

Beneficial Attributes of Pulse Starch:

- Starch Granule Size
- Low Glycemic Index/ Slowly Digestible
- Source of Resistant Starch/Dietary Fibre
- Source of Starch-Lipid Complex
- Mild Taste and Colour

Resistant starches are those resistant to digestion and able to pass through the small intestine unabsorbed. There are four main classes of resistant starches, including physically inaccessible starch (RS1), resistance granules (RS2), retrograded starch (RS3), and chemically modified starch (RS4). Patents and applications claims have outlined methods of preparation to produce both RS3 and RS4 class resistance starches from pulses for their use as a dietary fiber ingredient in food. One patent specifically leverages pea starch over corn because of its preferred colour and odour characteristics. Pulse starches have also been used in the development of starch-lipid complexes. As previously outlined, these may be employed as emulsifying agents in food.

Patent Details

ID#	APPLICATION	DETAILS
29	**Resistant Starch**	By comparison to indigestible polysaccharides, resistant starches do not produce the same molar about of n-butyrate, responsible for many positive health effects. The invention details a starch-based composition that has a high resistant starch content. It is a partially degraded starch which has undergone retrogradation and has a degree of polymerization between 10 and 35.
58	**Resistant Starch**	Type III resistant starch has more than half of the market share of its category due to good heat processing tolerance. However, the methods to create these starches are complex and there is a desire to use a simpler production method to obtain a type III resistant starch. Methods using pea starch to date have proven to be low efficiency with high cost. This invention details a method of preparation using acidolysis, pasting, debranching, aging, annealing, or pressing heat, which practically solves the problems of low resistant starch contents, low efficiency, poor heat resistances and high cost in preparing RS3 associated with common methods.

Patent Details

RESISTANT STARCH/STARCH-LIPID COMPLEX DEVELOPMENT (CONTINUED)		
ID#	**APPLICATION**	**DETAILS**
129	**Resistant Starch**	Phosphoric acid crosslinked starch creates a resistant starch type 4 which has several health benefits. However, there is a desire to reduce the amount of phosphorus as overconsumption is problematic. This invention presents a method of crosslinking pea starch with a reduced amount of phosphoric acid to create the resistant starch type 4. Notably pea starch is preferred due to the fact it has a whiter color and less odor than other starches such as corn.
50	**High Dietary-Fibre Ingredient**	Current dietary fiber products pose challenges including strong odor, taste, and deterioration of flavor/texture within a final product. Leguminous starch are used to create the high dietary fiber starch because they have the appropriate particle size distribution (70% from 18-35 microns) and gelatinization temperature (of 80 C). The starch is crosslinked with a phosphate agent. This product not only provides high fiber but also suitable texture and flavor improvements upon wheat di-starch phosphates
131	**Slowly Digestible Starch**	Producing a low-digestible starch, this invention relates to legume starches, in particular pea starches, with a slowly digestible starch content between 30 and 45% by weight, and a very slowly digestible starch content of 34 to 40% by weight.
28	**Starch-Lipid Complexes**	Typically, an exogenous reagent (octenyl succinic anhydride, pullanase, etc.) is required to product starch-lipid complexes which increases the manufacturing costs and has safety implications. The use of ultrasonication and heat treatment was successful in the creation of gelatinized pea starch-lipid compounds with high efficiency.
39	**Starch-Lipid Complexes**	The current preparation of a starch lipid complex has a low yield and is difficult to scale, costly, uses chemical reagents, and has poor stability. By comparison to more traditional starches, pea starch cost is lower, and it is easier to form resistant starch with. As such, pea starch is suggested for use in the formation of the health promoting starch lipid complexes.

INDUSTRIAL MATERIAL APPLICATIONS

Starches have many industrial applications as a lightweight, inexpensive component of materials, as a bio-based and/or biodegradable alternative to conventional materials, or as a functional component and/or coating. These industrial applications are an important consideration for processors as they can accommodate large volumes of starch. Historical adoption of pulse starches in this area has been limited by its commercial availability as an ingredient, however, with recent increases in global pulse processing capacities this may become an increasingly important end-use area. Patent and application claims leveraging the distinct properties of pulse starches have been noted and are described in further detail below. The high amylose content and ability of pulse starches to form films is consistently leveraged and cited as an advantage across applications.

ADHESIVES

Beneficial Attributes of Pulse Starch:

- Gelation
- Stability (Durable Over Time and at High Temperatures)
- Viscosity
- Biodegradable
- Limit Free Water
- Starch Granule Size
- Water Soluble
- Adhesion/Binding

The high amylose content of pulse starches has been leveraged to produce adhesives intended for the corrugated carboard industry. Specifically, native and modified high amylose starches are desired to provide high tack and wet bond strength. One patent specifically referenced the presence of other pulse seed components in air classified pea starch-rich flour to be advantageous because of their ability to limit viscosity in solution while reducing free water of the system. This leads to a faster permanent bond formation with limited evaporation. Another invention was able to produce an aqueous adhesive composition with desirable texture, stability, viscosity, and energy requirements through the combination of a cereal/tuber starch and a legume starch, limiting any disadvantages associated with their individual use.

Pea starch has also been leveraged as a biodegradable component of other adhesive formulations (i.e., paper glue, powdered white glue and adhesives intended for hot glass bottles) serving as suitable replacements for other materials such as casein and cross-linked wheat starch which have functional limitations. One invention specifically highlights pea starch as a safe alternative in wine cork adhesive production due to its high viscosity and gelation properties.

Patent Details

ADHESIVES		
ID#	APPLICATION	DETAILS
1	**Corrugated Carboard Adhesive**	It is desirable to develop corrugating adhesives that have high tack and wet bond strength, either containing fewer or free of chemical additives. The invention requires use of pea starch or starch with an amylose content between 30–40% to improve starch based corrugating adhesives. The starch is oxidized.
2	**Corrugated Carboard Adhesive**	The invention details the desire to develop a aqueous adhesive composition for the assembly of corrugated cardboard. Improvements upon other inventions are needed to increase the solids content. However, legume starch alone with a very high starch content is not suitable for the Minocar or Pristim processes due to maintenance of texture, stability, and viscosity and unacceptable energy requirements associated with its use. A cereal/tuber starch and a legume starch are used in combination and produced according to a Stein–Hall process. The combination mitigates the disadvantages associated with use of the individual starches alone and decreases the energy expenditure needs, gelatinization temperature and aids the simplicity of use regarding materials used, cost, supply, and performance.
7	**Corrugated Carboard Adhesive**	It is desirable to have a higher solids content in adhesive applications than traditional starches used for Stein–Hall type of adhesives provide. Preferably, "b" wheat starch is modified for this application but pea starch or others with a similar bimodal distribution can also be used. The modified version of the starch should contain an increased amount of non–starch, non–protein hydrophilic colloids indigenous to said starch that lend to reduced viscosities; air classified pea starch is mentioned as advantageous for this reason. The maintenance of a higher solids content at these reduced viscosities is possible using high amylose starch sources, specifically corn where legume starches are not presently available in sufficient commercial quantities to supply the corrugated adhesive industry. Nevertheless, high the use of high amylose starches results in improved green bond characteristics by limiting the free water available for evaporation following gelation and lending to a faster permanent bond formation.

Patent Details

ADHESIVES (CONTINUED)		
ID#	**APPLICATION**	**DETAILS**
6	**Powdered Glue**	There is a need for a more environmentally friendly alternative to white glue with vinyl. The current raw materials are costly, have formaldehyde residues, inconvenient transportation, and easily get moldy. The invention provides a preparation method for a powder type white emulsion that can be dissolved rapidly in cold water. Its main component is amylose starch. The claims detail pea, banana, and high straight chain starch.
8	**Glue for Labels on Glass Bottles**	Casien and starch materials do not always meet all criteria for the glue used for glass bottle labels. Specifically, casein labeling adhesive does not work well on hot glass as it needs to be washed before recycling, has an odor, and pronounced coloration, and a high cost compared to starch. However, starch materials often lack tack with poor resistance to water. Other resins have also been used but are not biodegradable. This invention details a composition that includes a native or modified legume starch that has an amylose content of at least 25–60% and is combined with a waxy maize starch to satisfy the requirements for a glue for labeling glass bottles. Pea starch that has not been chemically modified is said to replace crosslinked wheat starch. Use of a modified legume starch may allow for the replace of casein in traditional compositions.
190	**Wine Cork/ Stopper Adhesive**	Adhesives typically used to impregnate the cork granulates are generally isocyanate based. Due to the presence of compounds which may be inhaled or ingested, these adhesives must be prepared and used carefully. Further, there is potential for the adhesive to alter the flavor of the wine or alcohol that it encounters and poses microbial contamination risks during storage as they require a significant amount of water with an extended drying time during its production. To overcome the challenges associated with the traditional glue/adhesive material used for cork production, a pea-based starch is used due to its high amylose content which improves the flexibility and resistance of the starch to water, has a higher viscosity and better stability in gel than other starches. The pea starch serves as a binder to form a gel suitable for adhesion. The starch is chemically modified and helps reduce the risk of microbial migration during storage, reduce drying time, and suppresses subsequent risk of vapor explosion.

FILMS AND COATINGS

Beneficial Attributes of Pulse Starch:

- Biodegradable
- Limit Free Water
- Water Soluble
- Digestible
- Film-forming
- Controlled Rate of Release

Pulse starches are used in the production of films and coatings due to their ability to form strong gels with the benefit of being biodegradable, water-soluble, and digestible. As a result, films produced from pulse starches can be leveraged across a wide range of products in the food, packaging, environmental, pharmaceutical, cosmetic, and household industries. One challenge associated with the use of pulse starches in this application is its high viscosity and the need for high processing temperatures that, if not met, lead to a high rate of retrogradation and instability or cracking of the final product. Hydroxypropylated pea starch, suitable starch plasticizer pairings, and thermoplastic starch have all been highlighted as potential patented solutions to this challenge.

Patent Details

ID#	APPLICATION	DETAILS
10	**Biodegradable Film**	Creating a matrix suitable for the controlled release of an active agent into an environment, the controlled rate of biodegradation or digestion. This invention prepares copolymers comprising a synthetic polymer as the major component with minor amounts of starch as absorbents.
133	**Film Coating**	Film forming coatings protect active ingredients from the environment, modify rate of release, mask taste, protect color. Ideally, the film forming agent allows for an elastic and cohesive film, however, these films often crack and need a plasticizer. This invention sought to find an ideal starch composition that required less plasticizer, particularly sorbitol, than other compositions. Identification of a starch plasticizer pair allows for the film forming composition to overcome the challenges associated with prior art. This patent used preferably, a fluidized hydroxypropyl starch from smooth pea starch with an amylose content between 35 and 38 percent amylose.
134	**Film Coating**	A film forming coating makes it possible to mask flavors, modify taste and control release rates of components resistant to gastric juices. Current films have issues with cracking or breaking during storage, particularly in humid or high temperature conditions. Identification of a starch plasticizer pair allows for the film forming composition to overcome the challenges associated with prior art. Hydroxypropyl pea starch, preferably smooth pea starch is used as a film forming agent and has an amylose content between 35-38%.

Patent Details

FILMS AND COATINGS (CONTINUED)		
ID#	APPLICATION	DETAILS
141	**Film Coating**	Amylose starches require processing at high temperatures (80 °C) in order to prevent retrogradation when producing films. This is a particular nuisance in the coating of solid forms since conventional film-coating equipment is not designed to operate at such temperatures. This invention outlines a starchy composition for the film-coating of solid forms or the preparation of films, characterized in that it exhibits an amylose content of between 25 and 45%.
142	**Film Coating**	Amylose-rich starches are fairly restricting due to their rapid retrogradation when cooling. This patent describes a film-forming starch which can be employed at an operating temperature as close as possible to ambient temperature while remaining stable under these conditions.
144	**Packaging Films and Foils**	Traditional films and foils used for paper/cardboard packages are not recyclable or biodegradable. Attempts to use starches as biodegradable alternatives to plastic have not been successful. Hydroxypropyl high amylose pea starch is a suitable replacement for traditional (polyvinyl chloride, polystyrene, polyethylene, etc.) foils and films This invention provides a foil that has superior tear strength, extensibility, and high transparency.
169	**Cold-Water Soluble Film**	Polyvinyl alcohol is used for this application and is biodegradable but not biobased and thus relies on fossil fuels for its production. Substitutes including alginates, gums and starches often cause an increase in the viscosity of the solution which is problematic for the filters and connector tubes inside of washing machines and dish washers. To avoid this starch is often modified (through hydroxypropylation, oxidation, and functionalization with anhydrides) but the modification process can come with high environmental cost. The use of plasticizers such as PEG and glycerol also have their disadvantages. Thus, there is a need for a starch-based film that is biodegradable, biocompatible in the use of reagents and in industrial process of production. A thermoplastic starch derived from native pulse starch (pea, yellow pea, faba bean or chickpea) is used to develop a cold-water soluble film that has satisfactory mechanical properties such as elongation at break and sufficient solubility.
177	**Film**	Octenyl succinic acid peas starch ester is used to develop a biodegradable composite film and specifically added as a middle layer to help reduce the water absorption capacity of the film.

BIOPLASTICS

Beneficial Attributes of Pulse Starch:

- Biodegradable
- Reduced Plasticizer Requirements
- Filler

Many inventions have demonstrated the use of native and modified pulse starches blended with a plasticizer in the production of thermoplastic starch as bio-based alternative to conventional plastics. However, there are many challenges associated with the mechanical properties of these bioplastic materials including brittleness, low elasticity, water affinity, reduced strength and insufficient transparency. Specifically, legume starch is noted to present difficulties during the extrusion process because of its higher viscosity and melting temperatures. Many of the patents in this space present processing adjustments or other materials to be blended into the formulation to aid in improving the material characteristics of bioplastics. One patent specifically noted high amylose pea starch as more advantageous than corn because it reduced the amount of plasticizer needed.

Patent Details

ID#	APPLICATION	DETAILS
165	**Bioplastics**	There are currently structural stability problems associated with thermoplastic starches on the market for their use in biodegradable materials. Specifically, they are rigid and brittle due to their hygroscopicity and gradual recrystallization of the polymeric amylose and amylopectin chains during aging or the immiscibility of amylose and amylopectin in the plasticizer. Legume starch granules (C-type) have a higher degree of solubilization and require a longer time to swell. However, the high amylose content of legume starches present difficulties for the extrusion process due to their higher melting temperature and viscosity. This invention poses a new process for thermoplastic legume starch (preferably pea starch) that surmounts the hurdles associated with extrusion of legume (high amylose) starches. The process includes selecting an optimal plasticizer, preferably, glycerin for mixing and homogenizing. A drying, cooling, and extrusion step then follow.
166	**Bioplastics**	Conventional plastics have a heavy reliance on fossil fuels and are not biodegradable. Bio-based alternatives need mechanical improvements and are not always fully biodegradable. Development of a biobased and biodegradable alternative with improved mechanical properties relied up on the use of a native pea starch with an ideal amylose/amylopectin ratio.

Patent Details

BIOPLASTICS (CONTINUED)		
ID#	**APPLICATION**	**DETAILS**
167	**Bioplastics**	Amylose has great transparency, flexibility, high strength, and water insolubility but plasticizing is difficult. This patent highlights a method to improve the plasticizing process of high amylose starches, in which negative pressure is used to form cracks in the crystallize granule regions that allows the plasticizer to fully penetrate the granule. As a result of this granular disorder, the melting temperatures are lowered but the strength of amylose is maintained. This process successfully produces a plasticizing effect while reducing the overall quantity of plasticizer required.
170	**Bioplastics**	It is challenging to develop a starch material that has high technical value that can be processed into moldings and sheets which are environmentally safe and completely decompose into natural substances. High amylose pea starch (70% amylose) is used to create a thermoplastic material. High amylose pea was more advantageous than corn starch because it reduced the amount of plasticizer needed. An acyl modified starch is preferable.
171	**Bioplastics**	Discoloration during injection molding of starch is often unavoidable, further it is difficult to remove the mold, which is prone to surface defects including adhesions, warping and shrinking. During extrusion of starch, there is often a high surface roughness and tendency to adhesion. A destructurized starch that is wholly or partially chemically modified is used in this invention. Notably destructurized starch with amylose content less than 40% is suitable but high amylose (greater than 65%) is preferred.
172	**Bioplastics**	Though the film forming characteristics of amylose is desirable, it is also known to be brittle and have low elasticity. They also are not very stable, having low crease resistance and tensile strength, insufficient transparency, rough surfaces and require sophisticated equipment. This invention details amyloses that are swellable in cold water (but not soluble) and when heated above 80 °C at atmospheric pressure are homogenous, flowable quasi solutions typical of starch. When cooled to 50 °C, their state is maintained for 5 minutes and does not retrograde. The amyloses are obtained from high amylose starches (greater than 65%), specifically, high amylose pea starches. They are preferably obtained from a method by treatment of formamide solution with small proportion of dichloroacetic acid.

Patent Details

BIOPLASTICS (CONTINUED)		
ID#	APPLICATION	DETAILS
173	**Bioplastics**	Prior biodegradable plastics using starch have problems including the high cost of materials, being too reactive with water, brittleness over time or at elevated temperatures, and reduced tensile strength. This invention sought to make biodegradable and low-cost cellulose acetate plastics while maintaining the desired physical properties of conventional plastics. The composition contains 30–70% cellulose acetate, 10–60% unmodified raw starch and 5–35% plasticizer. The starch is selected from a group of sources including corn and tapioca, potato, sago, wheat, rye, pea, sorghum, rice, and arrowroot but must have an amylose content between 30–75%. The preferable starch is corn.
174	**Bioplastics**	There is a need for thermoplastic polymeric mixtures and blends that are fully biodegradable with improved physical properties under high relative humidity and reduced tendencies towards embrittlement under relatively low humidity conditions. The challenge is overcome by the use of a esterified starch having a degree of substitution of at least 1.5 (preferably acetates, starch propionates, starch butyrates, starch pentanoates, and starch hexanoates, and mixtures thereof).
175	**Bioplastics**	There is a need for thermoplastic polymeric mixtures and blends that are fully biodegradable with improved physical properties under high relative humidity and reduced tendencies towards embrittlement under relatively low humidity conditions. The challenge is overcome using a starch ester (acetate, propionate, butyrate, pentanates, hexanoates, or mixtures), from a variety of starch sources but must contain an amylose content of a least 50% by weight.
176	**Bioplastics**	Current transparent master batches used for plastic production are not environmentally friendly. The invention uses a starch with an amylose content of greater than 60% but can be derived from potato, pea, wheat or rice.

PAPER AND TEXTILES

Beneficial Attributes of Pulse Starch:

- Gelation
- Viscosity
- Biodegradable
- Adhesion/Binding

Patent and application claims have leveraged pulse starches in the wet end stages of paper manufacturing, as a surface agent for paper cups, in a spinning sizing agent for polyester yarn, and in the composition of facial cleansing towels. One patent specifically noted the ability of cationized pea starch to satisfy the processing and mechanical requirements of paper throughout production where potato, corn, wheat, cassava and rice were all noted to have individual challenges.

Patent Details

PAPER AND TEXTILES		
ID#	APPLICATION	DETAILS
145	**Paper Cup**	Native pea starch by exothermic reaction with STPP makes an anionic derivative that can be used as part of the surface agent to improve the quality of the paper cup.
146	**Paper**	Catioinized starch used on the wet end of the paper making process could be improved upon for their accessibility, processability, and having the capacity for rapid, strong, and solid attachment to cellulose. Corn and wheat starches have posed issues specifically with attachment to cellulose. Potato starch is disadvantaged as it requires the addition of fibrous suspension as close to the headbox as possible, and cassava and rice are disadvantaged due to the irregularity of quality. Legume starches, particularly peas, have been found capable of satisfying the requirements. The legume starch used is preferably 95 or 98% starch and an amylose content greater than 30% and less than 60%. The cationization of the legume starch is carried out by a chemical reaction, by condensing a cationic reagent with a hydroxyl group of the starch.
178	**Textile**	Current starch size slashing strength is not adequate, not wear resisting, and has an inadequate polyester fiber affinity. There is a desire to develop a starch at lower temperatures that can guarantee a stable weaving slurry of the yarn after starching. This invention details the development of a spinning sizing agent that includes nano SiO2 modified starch, pea starch, phosphate ester starch, and several other components. It is not clear why pea starch is utilized as opposed to other starches.
17	**Cleansing Cloth**	Traditional bath towels used to wash one's face are typically cotton which wears and tears easily, causes the towel to become hard, coarse and easily stick greasy dirt, breed bacteria and communicate illness. Thus, there is a desire to improve upon these challenges through the development of a konjak towel. Pea starch is used as part of the composition of the konjak towel but the patent does not detail why it is used.

CERAMIC FILTERS

Beneficial Attributes of Pulse Starch:

- Starch Granule Size
- Pore Forming

Pulse starches have been incorporated in mixtures of or in the coatings for ceramic bodies that are used for the filtration or purification of gaseous organic waste. For this application, the particle size of the starch is referenced as an important parameter. One patent noted incorporating mung bean starch specifically into the coating helped to alleviate cracking and breaking of honeycomb ceramic carriers.

Patent Details

ID#	APPLICATION	DETAILS
148	**Ceramic Exhaust Filter**	This patent relates to porous cordierite and pseudobrookite structured honeycomb bodies. Pea starch is one component of the batch composition mixture for a ceramic body which is often used in engine exhaust after treatment or other filtration applications. It is noted that in some embodiments the median pea starch particle size is d50. Only pea starch is mentioned in the claims, but corn starch is mentioned in the body of the patent.
149	**Ceramic Exhaust Filter**	This patent relates to batch compositions comprising pre-reacted inorganic particles and methods of manufacturing green body articles therefrom. Pea starch serves as a pore former and may be very highly cross linked for the batch composition for the ceramic body. The particle size is noted as dso = 26 um. Only pea starch is mentioned in the claims, but corn starch is mentioned in the body of the patent.
189	**Ceramic Waste Purification Treatment**	Currently the coating used for treatment of organic waste gas on the honeycomb ceramic carrier cracks easily and falls off. This invention utilizes mung bean starch. Experiments found that the loading capacity of the catalyst slurry of the honeycomb ceramic carrier is improved, and the shedding rate is reduced by adding a mung bean starch with a specific particles size.

FIBER GLASS

Beneficial Attributes of Pulse Starch:

- Viscosity
- Starch Granule Size
- Film-forming

Patents and application claims have utilized pea starch in slurries for coating of glass fibre. One patent specifically references pea starch to provide a stabile viscosity with good film formation and size which aids in preventing glass fibre fracture.

Patent Details

ID#	APPLICATION	DETAILS
26	**Fiber Glass**	The patent presents the challenge of a current slurry used for coating glass fiber that has too large of a coating force to warp yarn in the production process. This patent presents a new type of glass fiber electronic cloth slurry comprised of pea starch but does not detail the reason for using pea starch.
180	**Fiber Glass**	Current glass fiber production uses a film forming agent, but performance differs with different types of starch. Sometimes the viscosity is too low or high causing the yarn to be too weak or too strong. Corn starch is traditionally used but can be expensive. Rice starch was found to not be the correct size and led to glass fiber fracture. It is desired to reduce the cost of glass fiber production by finding a cheap film forming agent. Attempts have been made including hydroxypropylated pea starch but was still not satisfactory. In this invention, pea starch was used in the composition of the glass fiber infiltration agent. The pea starch has a stable viscosity and a size good for film formation and its price is lower by comparison to corn starch.

FOAMS

Beneficial Attributes of Pulse Starch:

- Biodegradable
- Attenuation Agent
- Filler

Pea starch has been applied as a biodegradable alternative to polystyrene, or as an attenuation agent which serves to improve the thermal insulation properties of polymeric foams. The high amylose content is referenced to confer the desired physical and thermal properties in this application.

Patent Details

ID#	APPLICATION	DETAILS
12	**Foam Insulation**	Typically, freon and hydrochloroflourocarbon foam blowing agents are used in polystyrene foams decreasing their ability to provide the desired thermal insulation. Though inorganic materials have been trialed, they are typically incompatible with relatively non-polar materials such as polystyrene, require a large volume, and lead to higher foam density which is not always desirable. Thus, there is a need to find an infrared attenuation agent for use in insulating polymer foams that avoid these difficulties. Pea starch with an amylose content of about 35% is utilized as an effective organic infrared attenuation agent that improves the thermal insulation property of polystyrene foams. By comparison to sorbitol, cellulose and silver color recycled paint, pea starch showed the highest R value, meaning it was the most effective.
168	**Foam**	There is a need to replace foamed materials such as polystyrene with biodegradable alternatives while maintaining the cost, brittleness, and other physical properties. This invention improves upon the prior art by utilizing high amylose starch as a loose filler injected into foamed material. The starch can be derived from maize, potato, tapioca, rice, wheat or pea but must be greater than 30% amylose content by weight.

MICROCAPSULES

Beneficial Attributes of Pulse Starch:

- Stability (Durable Over Time and at High Temperatures)
- Biodegradable
- Water Soluble
- Pore Forming
- Encapsulation

Patent and application claims have leveraged pulses starches in microcapsules and maltodextrin-based encapsulation systems that may be employed across industries (i.e food, pharmaceuticals, insecticidal).

Patent Details

ID#	APPLICATION	DETAILS
25	**Microcapsule**	In prior microcapsule systems, high shear forces destroy the microcapsule or conversely in of paste/paste compositions the shear forces are not strong enough to break the microcapsule and release its contents. This patent presents a method of creating a microcapsule that contains a porous, hollow core with a polymeric shell that can release gas upon contact with acid. Hydroxy propyl pea starch is one of the water-soluble components of this composition but why it is used is not noted.
135	**Encapsulation (food, pharmaceutical, insecticidal)**	Cyclodextrins are often used for encapsulation but are highly regulated, where high amylose starches have been considered as an alternative but require very strict conditions for preparation, use, and retrograde rapidly. Maltodextrin is presented as an alternative to cyclodextrins derived from amylose rich starches for encapsulation. Maltodextrin resulting from a high amylose (preferably 25-50%) starch was found to obtain a product that is very stable to high temperatures, has good solubilizing properties and high stability. The starch is chosen from legume plants.

OTHER INDUSTRIAL MATERIALS

Beneficial Attributes of Pulse Starch:	
• Viscosity	• Adhesion/Binding
• Biodegradable	• Attenuation Agent
• Water Soluble	• Filler

Application and patent claims have leveraged native and modified pulse starches in a series of other industrial materials:

- As part of a water reducing agent in concrete retarder mix
- As the high amylose component of a blend with hydroxycarboxylic acid to produce a bio-based thermoformable compound
- As a filler to improve the physical properties of aqueous epoxy coatings
- As a component of casting sand mixtures
- As part of a rice shell silicon-based fertilizer that is water soluble

Patent Details

OTHER INDUSTRIAL MATERIALS (CONTINUED)		
ID#	APPLICATION	DETAILS
11	**Concrete Retarder Mix**	Current concrete retarders have a limited application range dependent on the type of retarder. This invention proposes a new type of retarder that will improve the retarding effect and intensity without contamination. The water reducing agent is a mix of wheat, pea and konjak starch.
138	**Thermoformable Compound**	Synthetic thermoformed compounds pose serious risk to the environment. There is a need for a thermoformable material that is simple, not costly (particularly in terms of energy), not problematic for degradation and applicable to a wide range of thermoformed articles. The patent details a thermoformable compound containing an amylaceous component and a hydroxycarboxylic acid salt. The amylaceous component is obtained from a partially melted starch (not the same as a gelatinized but rather a thermal treatment that leads to the complete disappearance of starch granules). Partially melted starch includes the destruction of intermolecular hydrogen bonds with new hydrogen bond formation between water and hydroxy groups of the starch, though some starch granules persist. The patent details that the starch may come from a list of other sources, it prefers a high amylose starch (according to claim 7).
143	**Epoxy Coating**	There is a need to improve the wear resistance of aqueous epoxy coating. Modified mung bean starch (with glacial acetic acid) is used as a filler due to its large specific surface area, enhanced tensile ability, strong absorption effect to various substances, strong hydrophilicity, uniform dispersion, and high-water solubility.
178	**Molded Sand Casting**	Materials used to create molding sand for foundry good casting produces toxic gas and pollution upon discharge. The casting field is also growing, and the demands for steel casting performance are increasing. Pea starch is one component of the proposed new casting sand mixture. The patent does not detail why pea starch is used.
9	**Fertilizer**	Water soluble fertilizer is desired due to its high activity, full absorption, quick effect, and wide application in agriculture. Oxidized pea starch is used in the composition of the rice shell silicon powder used in the fertilizer. Pea starch has a certain viscosity that allows for the rice hull silicon powder to adhere to the ball body more easily. Pea starches hydrophilicity also allows it to absorb water form particles aiding in a more even distribution. Further, pea starch acts an adhesive that can quickly be decomposed by microorganisms, providing carbon for the soil.

COSMETIC AND PHARMACEUTICAL APPLICATIONS

Unlike other industrial applications, the cosmetic and pharmaceutical industries are only able to accommodate for a small volume of starch, however, purchasing in this area occurs at exponentially higher prices making it a desirable end-use category for starch. One limitation is the strict standards and purity requirements employed which means that only pea starch isolate is considered for these applications. Patent and application claims leveraging the distinct properties of pulse starches have been noted and are described in further detail below.

COSMETICS

Beneficial Attributes of Pulse Starch:

- Gelation
- Stability (Durable Over Time and at High Temperatures)
- Biodegradable
- Water Soluble
- Adhesion/Binding
- Film-forming
- Natural Origin
- Light-weight

Patent and application claims have leveraged modified pulse starches in skin and face makeup, mascara, and hair care products. A major benefit highlighted is its use as a functional, naturally derived ingredient. Pulse starches provide a film forming composition or serve in gelling and emulsions systems that are designed to impart specific benefits to the product. For patents related to makeup products notable improvements are sweat and sebum resistance, staying power, mechanical hold and adhesion to the skin while maintaining the ability to be removed upon washing. Wax-in-water emulsions prepared for mascara formulations have noted a withstanding to crumbling accompanied by a homogenous and durable application to the eyelashes. One patent specifically leveraged pulse starches in the composition of a hair care product that provides protection from thermal stress while also being light enough in body so as not to weigh down or cause rigidity to curly hair.

Patent Details

ID#	APPLICATION	DETAILS
14	**Makeup**	Current cosmetic compositions contain many synthetic polymers and are often difficult to rinse or remove. It is necessary to develop a cosmetic film forming composition of natural origin that has good mechanical hold during application but also the ability to be eliminated after application via washing. This invention leverages a least one hydrolyzed and alkylated leguminous starch in combination with a polyol and carrageenan to create the film forming composition.
13	**Face/Skin Makeup**	Cosmetic applications need to provide a product that is as natural as possible, protects the skin from environmental aggressions and fixes the product on the skin or appendages. This invention solves the needs of cosmetic compositions through use of an amylose rich starch as a film forming agent with barrier and fixing effects. The amylose content is between 30-75% and is a hydroxypropylated, hydrolyzed and pregelatinized pea starch and is the only starchy film forming agent in the composition.

Patent Details

COSMETICS (CONTINUED)		
ID#	APPLICATION	DETAILS
19	**Face/Skin Makeup**	Current natural ingredients used in makeup products have led to degradation of cosmetic properties. Combining a gelling system with a legume starch with 30–75% amylose produces a continuous, homogenous, intense, comfortable deposit, exhibiting sufficient resistance to sweat allowing makeup to last longer.
21	**Face/Skin Makeup**	Current natural ingredients used in makeup products have led to degradation of cosmetic properties. A legume starch and gelling system combined allowed the formation of a long-lasting and non-transfer makeup that has sufficient resistance to sweat and sebum.
23	**Face/Skin Makeup**	Current natural ingredients used in makeup products have led to degradation of cosmetic properties. An emulsion, legume starch, plasticizer and emulsifier improved the holding over time of makeup and improve resistance to sweat and sebum.
22	**Foundation**	Current natural ingredients used in makeup products have led to degradation of cosmetic properties. A cosmetic emulsion, legume starch, plasticizer and emulsifier improved up the foundation base's staying power.
24	**Face Mask**	Existing plant essence soft membrane powder facial mask has limited effect on skin care, specifically for mite removal and fungus resistance. This invention poses a new composition containing mung bean starch that provides mite removal and antifungal properties with no toxic side effects. Patent does not detail why mung bean starch is needed.
18	**Mascara**	Current natural mascara formulations have issues around forming sufficient sheathing films on the eyelashes and the films tend to crumble causing makeup to lose its intensity. The inventor discovered that by combining a wax-in-water emulsion, a legume starch with 30–75% amylose, a plasticizer, and emulsifier it was possible to form, a continuous, homogeneous, long-lasting deposit on the keratin fibers that does not crumble.
20	**Mascara**	Current natural ingredients used in makeup products have led to degradation of cosmetic properties. Combining a wax-in-water emulsion, a legume starch, a plasticizer, and emulsifier produced a continuous, homogenous, and long-lasting deposit that did not crumble and allowed the extending and curving of eyelashes to be durable over time.
15	**Hair Care**	Compositions used for maintaining curly hair typically comprise thickeners that weigh down the hair, thicken it or stiffen it. It is necessary to develop compositions that help define the curls without weighing them down while also protecting from thermal stress. Additionally, there is a strong demand for more natural products. Legume starch was found to reduce the oxidation of hair proteins on the cuticle and in the cortex of the hair, protecting it from heat, while also making it possible to retain curliness and increase the longevity of the holding of the curl without the rigidity associated with other compositions.

PHARMACEUTICALS

Beneficial Attributes of Pulse Starch:

- Gelation
- Water Soluble
- Digestible
- Film-forming
- Controlled Rate of Release
- Encapsulation
- Natural Origin

Pulse starches are leveraged in pharmaceutical applications serving as a disintegrants, or in the composition of capsules, tables, films, nanoparticles for drug delivery. The highlighted benefits of pulse starches in these applications are their ability to gel and form films, providing a suitable plant-derived alternative to gelatin, in addition to allowing for the controlled and slow release of the drug.

Patent Details

CAPSULES AND TABLETS	
ID#	**DETAILS**
152	There is a need for less frequent delivery of phenylephrine for patient convenience and sustainable availability of the active compound. The composition contains pea starch.
156	The invention seeks a solution to a double release table that has a simplified process, high production efficiency, quick response, good treatment effects and small adverse reactions. Pea starch is used in the composition of a coating for a double release tablet but why it is used is not detailed.
159	Currently capsules are made with gelatin which is an animal-derived product, and many are seeking plant-based alternatives. This invention details the use of a natural high amylose starch that is cross-linked to make the capsules.
163	The invention sought to develop a double layer chewable tablet of maca with improved dissolution rate, improved mouthfeel, and increased absorption in intestines. The chewable tablet contains a coating using preferably pea starch but does not denote why pea starch is preferable.
164	Gelatin in capsules has limitations including decreased dissolution rates after extended storage (due to crosslinking of gelatin) and potential for microbial contamination of gelatin solution during processing. There is a need for an alternative that can provide a similar elegant, shiny, high gloss, without the limitations of gelatin. Use of starch with an amylose content of at least 50%, notably pea starch. This includes modified and unmodified pea starch.

Patent Details

DISINTEGRANT	
ID#	DETAILS
153	Mucosal vaccine delivery is of interest after COVID exposed the need for rapid dissemination of vaccine for mass immunization. Pea starch is used as the disintegrating agent in solid dose forms.
161	Absorption of poor water-soluble drugs is controlled by the dissolution rate in the gastrointestinal fluid at the absorption site. There is a need to improve the administration of BCS Class II active compounds such as fenofibrate despite their low solubility. Bean and pea starches are listed as potential film forming polymers for a formulation that enables the slow realize of drugs.
162	There is a desire and need to control the release of certain drugs. Though other ingredients have been used they are not always cost effective or pure. Cross linked high amylose starches with functional groups provide a starch that is resistant to amylases and those provides slow release of oral pharmaceuticals.

Patent Details

OTHER PHARMACEUTICAL APPLICATIONS		
ID#	APPLICATION	DETAILS
150	**Nanoparticles**	There is a need to improve the bioavailability of tacrolimus, the immunosuppressive drug used mainly after allogeneic organ transplant to lower rejection. The invention provides a method to improve the water solubility of tacrolimus and uses a pea starch in the composition to do so.
151	**Nanoparticles**	Vaccines are typically administered via subcutaneous or intramuscular routes but are often invasive, painful and require skilled professionals. Other delivery routes are being tested to overcome these challenges. Pregelatinized hydroxypropyl pea starch obtains the desired film strength and disintegration properties for the nanoparticles delivered through oral vaccine. The results of the preliminary study suggesting that ODF loaded with vaccine nanoparticles is a promising immunization delivery system using the buccal route.
158	**Nano-sponge**	Apomorphine has low oral bioavailability but there is a desire to provide an extended and controlled release formulation that can maintain a high bioavailability while being administered via different routes. A nano-sponge structure containing a crosslinked polymer of dextrin or maltodextrin was found to enable administration in a controlled and extended way. Maltodextrin is preferably derived from a legume starch with an amylose content of 25-50%. The cross-linking compound is selected from dianhydride, sodium trimetaphosphate and citric acid.

Patent Details

OTHER PHARMACEUTICAL APPLICATIONS (CONTINUED)		
ID#	**APPLICATION**	**DETAILS**
155	**Nano-sponge**	Cyclodextrins are typical means of encapsulation. However, maltodextrins have also been used for encapsulation purposes and are subjected to less strict regulations. Nano-sponges have also been explored and more specifically glutathione responsive nano-sponges, but they require reaction with an organic solvent that needs to be disposed of. This invention details the development of a glutathione responsive nano-sponge created by a cross linked polymer having disulfide bridges that uses a solvent that does not have disposal issues, such as water. The starch is preferably pea starch (in one embodiment, in a second embodiment it is a waxy maize starch). The amylose content is ideally 35-38%.
154	**Orwal Film**	There is a need to promote compliance of schizophrenia medication and thus develop an oral film preparation that masks bitter taste. A modified maltodextrin and hydroxypropyl pea starch is used in the composition.
157	**Peptide-Mimotrope**	A mimotope is a macromolecule, often a peptide, which mimics the structure of an epitope. Therefore, it causes a cell-based response or an antibody response like one elicited by the natural epitope. The challenge with epitopes is that most of them do not elicit a significant immune response and are therefore poor immunogens. Hydroxyproply pea starch with calcium alginate and methacrylic acid are used for micro-encapsulating and film forming for a peptide-mimotope based vaccine delivery to treat positive colorectal cancers.
160	**Excipient**	Lack of solubility inhibits drug bioavailability. The invention improves upon the solubility and bioavailability of active pharmaceutical ingredients through blending a dry or substantially dry mixture of the APE and solubility enhancing excipient with kneading or extrusion with applied attrition force to increase solubility. Hydroxypropyl pea starch is part of the composition but its reason for use is not mentioned.

ANIMAL FEED AND PET FOOD

Beneficial Attributes of Pulse Starch:

- Adhesion/Binding
- Digestible
- Controlled Rate of Release

Pulse starches have traditionally been incorporated into animal feed as a carbohydrate-rich energy source and are excellent binding agents which is valuable for the production of feed pellets for various applications, including livestock and aquaculture. This is an important industry for pulse ingredient processors due to large consumption volumes, however, material sold into these applications are at lower price points compared to the aforementioned industries. Patent and application claims have utilized pulse starches in formulations for pigs, geese, and fish.

Pea starch has also been leveraged as a functional component of pet food formulations as a binding and/or texturing agent. One patent specifically incorporated mung bean starch into the compositions of a hydrogel fish bait as a more environmentally friendly material which also benefited from a more controlled release rate of the fish attracting agent.

Patent Details

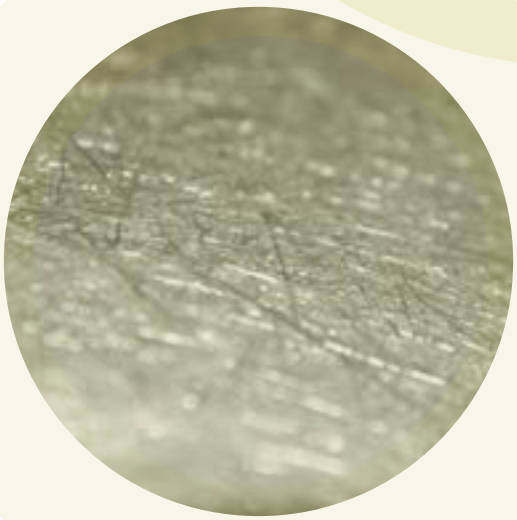
ANIMAL FEED AND PET FOOD		
ID#	APPLICATION	DETAILS
182	**Pig Feed**	The combination of pea starch and either corn or cassava starch significantly increases the growth performance of fattening pigs, which improves slaughtering performance and meat quality.
186	**Pig Feed**	This invention designs a miscellaneous meal type fermentation concentrated feeding stuff which is free from antibiotics to improve the production performance of the sows in lactation. The recipe includes broad bean powder starch albumen.
184	**Fish Feed**	Micropterus salmoides have very limited utilization capacity of carbohydrates in feed. A mixture of fish meal, chicken meal, pork meal, rice protein powder, corn protein powder, bean pulp, soybean oil, soybean phospholipid oil, beer yeast, pea starch, gluten powder, pullulanase, monocalcium phosphate, and vitamins is used to improve the tolerance of micropterus salmoides to sugar.
188	**Fish Feed**	At present, commercial compound feed for micropterus salmoides generally needs fish meal with the proportion of more than 40 percent to meet growth requirements. However, the fish meal resource is increasingly in shortage and the price is continuously rising all over the world and is not beneficial to the sustainable development of fishery resources. Therefore, there is a need to develop a compound feed for micropterus salmoides with low fish meal. This patent describes a low-fish meal compound that comprises 2:3:5 parts by weight of scutellaria baicalensis, phellodendron amurense and rheum officinale. It also contains chicken meal, pork meal, spray-dried porcine hemoglobin powder, spray-dried porcine plasma protein powder, high-temperature and high-pressure hydrolyzed feather meal, squid liver paste, shrimp paste, corn protein powder, bean pulp, fish oil, soybean phospholipid oil, beer yeast, a traditional Chinese medicine complexing agent, pea starch, gluten powder, monocalcium phosphate, taurine, choline chloride, compound vitamins, compound mineral substances, an antioxidant, a mildew preventive and rice bran meal.
185	**Goose Feed**	Incorporating a substitute to antibiotics into goose feed. The recipe incorporates green gram starch.
187	**Wet Pet Food**	Creating a moist meat-based food composition intended for pets, with a specific desired texture. Native and purified pea starch is used as a texturizing agent. It is introduced into the formulation at a content of between 4.5% and 10% by weight, but preferable between 5% and 8%.

Patent Details

ANIMAL FEED AND PET FOOD (CONTINUED)		
ID#	**APPLICATION**	**DETAILS**
183	**Wet Pet Food**	This invention serves to find alternatives to wheat flour as binding agents in wet pet food. The purified pea starch ensures the required firmness and stability for the pet food product.
27	**Fish Bait**	Current fish bait hydrogels aim to be environmentally friendly, while also releasing fish attracting agents in the water. There is a desire to improve upon the prior art by creating a hydrogel fish bait that can effectively continuously release the fish attracting agent for the purpose of a long-acting fish bait. Mung bean starch is used as part of the composition for the hydrogel fish bait and may help to control the release rate of the fish attracting agent.

SUMMARY: KEY ATTRIBUTES OF PULSE STARCHES

Native and modified pulse starches have been leveraged for their individual attributes, or those they impart when included in the compositions of, an array of patent and application claims across industries. The following tables highlight the key properties of pulses starches that are important across food and non-food applications as presented in the IP analysis.



FOOD INDUSTRY APPLICATIONS														
Attributes associated with pulse starches, or the compositions including pulse starches	Analog	Bakery	Batter, Breading & Coating Systems	Beverages	Confectionary & Desserts	Dairy Products	Food Pigments & Organic Compounds	Food Additives	Meat Products	Noodles & Pasta	Resistant Starch & Starch-Lipid Complexes	RTE Meals	Sauces, Soups, Dressings & Spreads	Snacks
Gelling	x	x	x		x	x		x		x				
Water binding	x		x		x	x		x	x				x	
Thickening	x	x	x		x	x		x	x			x	x	
Solubility		x					x						x	
Texture enhancing	x	x	x		x	x				x			x	x
Film-formation			x				x							
Starch granule size			x								x			
Crystallinity development			x											
Retention capacity							x							
Encapsulation agent							x							
Stability [a]							x						x	
Emulsifier								x					x	
Foaming agent								x						
Gluten-free	x	x	x							x				x
Low glycemic index/slowly digestible		x		x			x			x	x			
Source of resistant starch/ dietary fibre		x		x		x					x		x	
Source of starch-lipid complex								x			x			
Sugar/fat reduction		x	x										x	
Clean label			x			x		x						
Mild taste and colour							x				x		x	x

[a] Under high oxidative, temperature and shear conditions

Attributes associated with pulse starches, or the compositions including pulse starches	INDUSTRIAL MATERIALS									COSMETICS	PHARMACEUTICALS	ANIMAL FEED & PET FOOD MATERIALS
	Adhesives	Films & Coatings	Bioplastics	Paper & Textiles	Ceramic Filters	Fibre Glass	Foams	Microcapsules	Other Materials			
Gelation	x			x						x	x	
Stability [a]	x							x		x		
Viscosity	x			x		x			x			
Biodegradable	x	x	x	x			x	x	x	x		
Limit free water	x	x										
Starch granule size	x				x	x						
Water soluble	x	x						x	x	x	x	
Adhesion/ binding	x			x					x	x		x
Digestible		x									x	x
Film-forming		x				x				x	x	
Controlled rate of release		x									x	x
Reduced plasticizer requirements			x									
Pore forming					x			x				
Attenuation agent							x		x			
Filler			x				x		x			
Encapsulation								x			x	
Natural origin										x	x	
Light-weight										x		

[a] Durable over time and at high temperatures

Patent Reference Numbers

ID#	PUBLICATION#	FILE DATE
1	US20220135854	2020-01-08
2	FR2881749	2005-02-07
3	US8425677	2006-01-24
4	IN259512	2006-01-16
5	CN111019601	2019-12-26
6	CN103468162	2013-09-29
7	US4587332	1985-02-12
8	US8470119	2004-05-28
9	CN113024308	2021-04-01
10	EP0491813	1990-09-14
11	CN106316200	2016-08-19
12	US10519290	2018-04-03
13	FR3094223	2019-03-29
14	US20210330570	2019-12-13
15	WO2022199889	2022-03-17
16	FR3123212	2022-05-25
17	CN1187334	1996-04-18
18	FR3094222	2019-03-29
19	FR3094226	2019-03-29
20	US20220192959	2020-03-27
21	US20220192960	2020-03-27
22	FR3094228	2019-03-29
23	US20220160613	2020-03-27
24	CN112294736	2020-10-31
25	US20220211611	2020-05-27
26	CN112408815	2020-10-28
27	CN112321850	2020-10-12
28	CN115466332	2022-09-21
29	US6043229	1997-12-02
30	EP0820239	1996-04-15

ID#	PUBLICATION#	FILE DATE
31	CN108497464	2018-04-16
32	CN113647588	2021-08-10
33	CN110063490	2019-06-04
34	EP4122329	2021-02-03
35	US6013299	1997-11-04
36	AU2017251143	2017-04-10
37	CN115428901	2022-09-12
38	US10975404	2020-05-13
39	CN113383964	2021-06-18
40	CN109674029	2019-03-08
41	US8883243	2008-07-09
42	WO2022073646	2021-10-06
43	EP3794960	2019-09-18
44	US20220338515	2020-09-14
45	CO2022003032	2022-03-16
46	US8512779	2005-01-19
47	FR3108472	2020-03-30
48	US20230069481	2021-03-29
49	IL286714	2021-09-26
50	US20200392256	2019-02-22
51	CN106819791	2016-12-15
52	CN106418455	2016-10-21
53	US5549923	1994-03-30
54	US20210259293	2019-07-02
55	US6177123	1997-07-11
56	US4810517	1988-01-12
57	CN104431751	2014-12-17
58	CN115595346	2022-12-15
59	CN113729206	2021-09-07
60	CN111560304	2020-05-25

Patent Reference Numbers

ID#	PUBLICATION#	FILE DATE
61	RU2489901	2009-11-09
62	CN111213690	2020-02-03
63	CN106332939	2016-08-26
64	US11172689	2019-09-05
65	CN113841725	2021-10-08
66	CN110859222	2019-11-29
67	EP3297449	2016-05-17
68	EP1645196	2005-09-26
69	CN104719585	2015-04-09
70	EP3209141	2015-10-12
71	CN1056500	1995-09-29
72	NO163993	1986-03-07
73	CN1104864	1994-01-07
74	CN102960640	2012-11-30
75	CN112155162	2020-09-29
76	US11470865	2018-10-01
77	EP3466271	2017-10-03
78	EP3466272	2017-10-03
79	CO2020003949	2020-03-31
80	CO2020003950	2020-03-31
81	US20200245653	2018-10-01
82	CN110140875	2019-06-12
83	EP3987941	2020-10-20
84	WO2022083893	2021-10-19
85	EP0240313	1987-03-31
86	WO2022181768	2022-02-25
87	CN112586678	2020-12-23
88	GR1009488	2017-09-18
89	CN110810742	2019-09-11
90	US20220386665	2022-07-11

ID#	PUBLICATION#	FILE DATE
91	CN1091594	1993-03-03
92	FR2986134	2012-02-01
93	CN114794189	2022-05-23
94	CN103110060	2013-02-26
95	CN102113653	2010-06-08
96	CN1416726	2002-12-05
97	CN1416727	2002-12-05
98	CN1083669	1992-09-05
99	CN1063999	1992-02-21
100	CN1064521	1997-04-20
101	CA1278211	1986-02-26
102	CN1415254	2002-09-27
103	EP2866583	2013-05-30
104	PL434631	2020-07-12
105	CN109329748	2018-12-14
106	FR3113562	2020-09-02
107	CN112120162	2020-09-30
108	DE102016005602	2016-05-10
109	US6419972	2000-09-29
110	US6419972	2000-09-29
111	WO2022160639	2021-08-03
112	WO2022160640	2021-08-03
113	US5324532	1993-11-04
114	CN111000145	2019-11-11
115	TW202218560	2021-08-06
116	CN113040331	2019-12-27
117	EP3864967	2020-03-19
118	US20210282434	2021-06-02
119	CN114651939	2022-04-15
120	CN114732107	2020-12-24

Patent Reference Numbers

ID#	PUBLICATION#	FILE DATE
121	CN107692050	2017-10-31
122	US20220240555	2021-02-01
123	CN108936335	2018-07-30
124	CN108936336	2018-07-30
125	CO2022003542	2022-03-25
126	CN113598330	2021-07-02
127	US6228419	1998-10-20
128	EP3232815	2015-12-11
129	US20210246230	2019-06-14
130	FR3026741	2014-10-01
131	US20220400715	2020-11-19
132	CN114947052	2022-02-28
133	IN308391	2014-03-28
134	AU2019210521	2019-07-30
135	US11033504	2018-08-06
136	EP2978815	2014-03-28
137	IN201727002267	2017-01-20
138	US5360473	1992-01-30
139	CN113045679	2019-12-27
140	US7781578	2006-02-14
141	US8652513	2004-08-18
142	IN247678	2006-05-15
143	CN115433503	2022-10-10
144	US6512108	2001-02-27
145	CN107411473	2015-08-11
146	US8911593	2010-03-05
147	CN102674648	2012-06-01
148	EP3844123	2019-08-29
149	EP3694824	2018-10-31
150	US20220079872	2021-11-23

ID#	PUBLICATION#	FILE DATE
151	US10849962	2018-10-26
152	IN2008CN06599	2008-12-01
153	WO2022067273	2021-10-22
154	CN108685876	2017-04-11
155	US11440975	2019-04-19
156	CN112472679	2020-12-02
157	MY189822	2017-10-30
158	WO2022223522	2022-04-19
159	CN103070845	2013-01-14
160	US20220175677	2020-04-07
161	US11497811	2017-11-21
162	NO329257	2000-08-23
163	CN105106148	2015-09-11
164	US8722089	2009-02-17
165	ES2364831	2010-02-18
166	WO2022157380	2022-01-25
167	CN104558700	2014-12-31
168	US5736586	1995-08-08
169	WO2023017085	2022-08-10
170	US5367067	1993-03-01
171	US5480923	1994-08-12
172	US5374304	1993-11-04
173	US5288318	1993-07-01
174	US5587412	1995-02-06
175	US5656682	1993-11-19
176	CN103724674	2013-12-30
177	CN113201209	2021-05-31
178	CN104057020	2014-05-28
179	CN106480728	2016-11-17
180	CN109133673	2018-09-13

Patent Reference Numbers

ID#	PUBLICATION#	FILE DATE
181	CN103284318	2013-06-20
182	AU2020103991	2020-12-09
183	FR3106723	2020-01-30
184	CN111938042	2020-08-26
185	CN103141678	2013-03-06
186	CN103815199	2014-03-04
187	EP4096427	2021-01-25
188	CN111772062	2020-08-26
189	CN111908937	2020-07-08

PULSE CANADA

www.pulsecanada.com
920–220 Portage Ave.
Winnipeg, MB
Canada R3C 0A5