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Table of Contents and Report Summary

S. K. Patil and Associates, Inc.

Value Added Modified Starches:
1. CWS (cold water swelling),
2. Physically Modified Starches &
3. Enzyme Modified Starches
Process, Applications, Products and Markets
November 2012

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TABLE OF CONTENTS

2. Physically Modified Starches

3. Enzyme Modified Starches

REPORT SCOPE

This report is a combination of three important modified starch categories; Cold Water Swelling, Physically Modified and Enzyme Modified Starches. The report covers products, applications, markets and research activities and selected pertinent patents.
The analysis includes definitions, current product offerings and market detail on the major food segments.

Report provides important insights into applications served by modified starches reported. Market information can provide important direction to the developers and research managers. The food manufacturers can also benefit from the information provided for their current and new product development efforts. Research presented in the form of selected abstracts with who is doing what and which areas. List of patents for each categories compliment the research abstracts presented based on our extensive research of publications and patents.

Report is presented in three separate groups of modified starch products below:

GENERAL SUMMARY – Report 1, 2, and 3

The three separate groups of reports 1, 2 and 3 present most pertinent material on this highest value modified starches mainly for food applications.

1. CWS – Cold Water Swelling Starch;
2. Physically modified starches AND;
3. Enzyme modified starches

1. CWS – Cold Water Swelling Starch

Cold water swelling and spray cooked starches are marketed heavily for instant preparation, flavor encapsulation and convenience aspects of food preparation. Granular cold water swelling/soluble starches are produced by treatment with an alcohol and a strong base to effect swelling of the starch granules and conversion to a form having increased cold water solubility. Original process described in KSU patent was not economical. Alcohol with alkali was the original work by Jay-Lin Jane and Paul Sieb (1992) was not practices due to high alcohol usage and very high cost (see abstract).

Specialty starches labeled instant, granular or cold water-swelling hydrate at lower temperatures and eliminate the heating step. In addition to convenience and significant savings in time, labor, energy and equipment, these also improve the quality of delicate products normally harmed by heat.

Total US market for cold water swelling/spray cooked starches in 2011 is estimated to be 85 MM lbs annually. This includes a wide variety of typical food applications as well as specific specialty applications. Three segments; convenience, dairy and bakery utilize almost 50 mm pounds with one user using ~ 15 mm lbs in single application, pudding. Our projection is that CWS starch consumption will grow > 100 million lbs by rear 2017.

Research activities presented in the form of selected research paper abstracts and patents show activities in several fronts; convenience, nutrition, novel flavor encapsulation and dairy among others. Key applications and customers provided in the report present that growth areas for CWS starches.

2. Physically Modified Starch

One of the recent developments in starch technology is development and marketing of physically modified starches that perform similar to chemically modified starches in food applications. Physically modified starches represent the greatest opportunity for growth in the starch industry. As the desire to provide cleaner labels or “pantry friendly” ingredients, there is a significant interest in these products by all major food manufacturers. Our estimate is that this will be one of the main areas of opportunities in starch industry and estimate more than doubling of this market in the US to ~ 90 - 100 million lbs in next 3 – 5 yrs. Growth is driven by “Organic”, “Natural” and “Clean Label Foods” New technologies and new products will continue to come to market going forward.

Physically modified starches represent a great opportunity for growth in the starch industry. As the desire to provide cleaner labels or “pantry friendly”, “clean label” ingredients, there is a significant interest in these products by all major food manufacturers.

Ingredion/National Food Innovations owns this market with a total of 20 starch products based on waxy maize, tapioca, waxy rice and potato, 4 wheat flours and blend options. In 2011 the

total current market in the US from all producers is estimated at ~ 47 million lbs and growing at about 6 to 8 % in the past 2 yrs after a strong growth of > 10 % in the previous 2 yrs (2008 & 2009). US has ~ 40 % of the market share of this group of modified starches. We estimate that by 2017 this market will grow to ~ 135 million in the US (Table 7). Primary driver is “Natural” and “Clean label” This report is the most recent information compiled that provide an excellent review of this new novel food ingredient group. We are in process to analyze our private estimates further in multiple food segments and sub segments. Taking into account of growth in natural, organic, simple/clean label and wellness products potential going forward physically modified starches can account for 4 to 5 % of total food modified starches worldwide to ~ 250 to 300 million pounds in 5 to 6 yrs. This seems aggressive estimate, however it is achievable.

In response to consumer demands, manufacturers are trying to simplify ingredient lists by removing and replacing artificial additives. There are a range of projects trying to find technical solutions that enable manufacturers to produce so called "clean label" products. This report presents the material collected from many sources. Several consumer products bearing “clean label” have been introduced and more are development.
Future development prospects for physically modified starches remain very bright with several possibilities of novel treatments that can result modified starch properties without chemical modification. This also means opportunities can be with products using other sources of starches besides high amylase starch sources. We have presented some of the abstracts and remain very active in this area to support novel technology and market development worldwide.

3. Enzyme modified starches

Enzyme modified starches remain a active area in the functional modified starches. Enzyme modification can be tailor to very specific properties because of specificity of enzyme attack and very selective modification of targeted food and industrial segment applications demands going forward. This starch category can also qualify for “clean label” products if chemical modification is not utilized with enzyme modification.

A large-scale starch processing industry has emerged in the last century. In the past decades, we have seen a shift from the acid hydrolysis of starch to the use of starch-converting enzymes in the production of maltodextrin, modified starches, or glucose and fructose syrups. In recent year’s use of several enzymes in biofuels, bioplastics, detergents, feed and several bioprocessed products such as organic acids, amino acids and many other monomers for food

& industrial applications has over passed the classical use of enzymes in starch hydrolysis products such as sweeteners, maltodextrins, etc.

Besides the use in starch hydrolysis, starch-converting enzymes are also used in a number of other industrial applications, such as laundry and porcelain detergents or as anti-staling agents in baking. A number of these starch-converting enzymes belong to a single family: the α-amylase family or family13 glycosyl hydrolyses. Starch modification by enzymes is in infancy with very insignificant commercial products. However due to their novel functions, clean label needs and cost efficiencies/environmental issues in industrial segments such a paper, detergents, etc growth will enhance as science and market develop going forward.

A plant and chemical-free alternative to gelatin is amylomaltase-(AM) glucanotransferase; E.C. 2.4.1.25) modified starches that is expected to find application in the food industry. AVEBE launched in 2007 an AM-modified potato starch that is used as fat replacer and enhancer of creaminess in yoghurt. The search for a gelatin-replacer has been ongoing for many years, and several potential polysaccharide-based alternatives for the food industry.

There is a large industrial interest in replacing expensive or otherwise unwanted gel formers such as gum arabic, pectin and gelatin with starch in food products. Starch is an alternative, but amongst the known problems of native starch are sub-optimal textural properties

It is difficult to predict whether all of the proposed enzymatic starch processing technologies will be implemented by the food industry, but it is fair to say that the EteniaTM starch made by 4 α-GT treatments are commercially available and are increasingly being used as food ingredient. In future novel enzyme activities that are able of slowing down the degradation of starch in the gastrointestinal tract may create new routes toward healthy starches. Such enzymes can thus replace chemical steps that introduce cross-linkages in starch.