OPEN ACCESS
Scholars International Journal of Chemistry and Material Sciences
Abbreviated Key Title: Sch Int J Chem Mater Sci
ISSN 2616-8669 (Print) | ISSN 2617-6556 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: http://saudijournals.com

Review Article

A New Starches Extracted from Non- Conventional Sources are the Vogue for Pharmaceutical Industry: A Review

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DOI: https://doi.org/10.36348/sijcms.2024.v07i10.002 | **Received:** 22.09.2024 | **Accepted:** 26.10.2024 | **Published:** 31.10.2024

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Abstract

Industrially, starch is obtained from cereal grains such as wheat and maize (corn), or from tubers, such as potatoes, tapioca, and arrowroot, or from the pith of the sago plant. By far, the larger part of the starch is obtained from maize, wheat, potato, and tapioca. Starch is present in almost all the tissue such as leaves, roots, tubers, seeds, stems, flowers, etc. of green plants however there are some plants which are grown commercially for the starch which includes cereal such as wheat, corn, sorghum, and rice, tuber mainly potato, root like tapioca and arrowroot, stem of sago, and legume crops mainly pea. Worldwide production of an overview on applications of starch 142 starch is depending on the use of cereals as the raw materials. Normally starch from Conventional sources of starch include sources like cereal corps and legume seeds, tuber crops, and some root tubers is used in large amount in the field of pharmacy. Due to unbelievable increasing demand for starch some nonconventional starch resources have been investigated in recent Years.

Keywords: Starch, Maize, Potato, Wheat, Arrowroot, Pea.

INTRODUCTION

Starch is the most vital carbohydrate in the human diet and is major constituent of basic foods such as potatoes, rice, wheat, cassava, and corn. It is made up of glucose units linked together by glycosidic bond. Plants store glucose as the polysaccharide starch [1]. Depending on the plant, starch contains 20 to 25% amylose and 75 to 80% amylopectin [1, 2]. Amylose is primarily a linear chain of D-glucose units linked by α-1→4 linkages. However, some amylose molecules have about 0.3-0.5% of α-1→6 linkages (branches). Amylopectin is a branched polymer of glucose unit, linked with α-D-(1→4) glycosidic bond with the branching of α-D-(1→6) bond occur every 24 to 30 glucose units [3, 2].

In the field of pharmaceutical starch is becoming more valuable substance because of its many advantages, such as it is versatile and inexpensive polysaccharide which has received great attention in drug delivery applications as they are hydrophilic, biodegradable, and biocompatible with tissue and cells (Suk Fun Chin *et al.*, 2014). Starches are conventionally used as diluent, disintegrant, lubricant, binders, and glidants. But now a day they are also used in drug delivery system. With emerging properties they are now entered to the field of nanotechnology. They are widely using for controlled release of drug and targeted release of drug (Mayuri Phukan *et al.*, 2022). Normally starch from Conventional sources of starch include sources like cereal corps and legume seeds, tuber crops, and some root tubers is used in large amount in the field of pharmacy. Due to unbelievable increasing demand for starch some nonconventional starch resources have been investigated in recent Years.

Inception of Starch

Starch extraction was first described in the natural history of Pliny the Elder, around AD77-79. Around 30,000 years ago Starch grains from the rhizomes of Typhus cattails, Bulrushes cattails, was used as flour in certain grinding stones, in Europe as early as 30,000 years ago. Starchy grain sorghum has been discovered, in the Ngalueh Cave, Mozambique dating back up to 100,000 years ago. Ancient Egypt Pure extracted wheat starch paste was used may be to glue papyrus. The Romans also used it in cosmetic creams, to powder the hair and to thicken the sauces. Persians and Indians used it to make dishes similar to gothumi wheat halva. Rice starch as a paper surface coating has been used in paper production in China since 700 CE.

CLASSIFICATION OF STARCH

Starch can be divided into three categories based on its nutritional classification: rapidly digestible starch, slowly digestible starch and resistant starch. Resistant starch is not digested in the small intestine and enters the colon for fermentation (Chung, H. J., *et al*., 2011). The starch molecule can be extracted and sold as such (native starch), but it can also undergo several processing operations to improve its proprieties and enlarge the range of its uses (modified and hydrolyzed starches). Native starch is the starch chain extracted from raw material in its original form. Modified starches are starches that are modified by a chemical, physical or enzymatic process. Hydrolyzed starch is the starch chain broken into smaller glucose chains via a hydrolysis reaction.

Native starches has limited application in industry because it exhibits some disadvantages such as a low shear resistance, high retrogradation and syneresis, and it is often modified by physical, chemical or enzymatic processes or a combination thereof to provide desirable functional properties for determined uses.

Physically modified starch can be considered as a natural material and a highly safe ingredient (Klein, B., Pinto, *et al*., 2013). Nevertheless, the commonly used ways of obtaining modified starch are complex, expensive and time consuming (Sofi, B.A., *et al*., 2013) (Wani, I.A., *et al*., 2014) and frequently employ treatments with hazardous chemicals. Many industrial applications require the modification of native starches, including oxidation, esterification, hydroxy methylation, dextrinization and cross-linking. These modifications overcome the limitations of native starch properties (e.g., stabilizing the polymers against severe heating, shear, freezing or storage). Such modified starches have innumerable applications in the food industry, particularly in confectionery and bakery processes for thickening and emulsification, and in non-food sectors as adhesive gums, biodegradable materials and sizing agents in the textile and paper industries (Santelia, D., *et al*., 2011).

Conventional Sources of Starch

Industrially, starch is obtained from cereal grains such as wheat and maize (corn), or from tubers, such as potatoes, tapioca, and arrow root, or from the pith of the sago plant. By far, the larger part of the starch is obtained from maize, wheat, potato, and tapioca. Starches from the different sources have different properties that affect their functionality and, therefore, it is in their end-of-use. In India only starches from maize and tapioca are produced in a significant amount (Fausto F Dias *et al*., 1999). Starch is the polysaccharide which is the second most important renewable resource in terms of availability after cellulose; worldwide production of starch is more than 50 million ton per year (Endres H.J *et al*., 2012). Starch is present in almost all the tissue such as leaves, roots, tubers, seeds, stems, flowers, etc. of green plants however there are some plants which are grown commercially for the starch which includes cereal such as wheat, corn, sorghum, and rice, tuber mainly potato, root like tapioca and arrowroot, stem of sago, and legume crops mainly pea. Worldwide production of an overview on applications of starch 142 starch is depending on the use of cereals as the raw materials. Corn or maize is the main crop which supplies around 80% of the global starch market conquering the title of world largest industry situated in U.S. (Bergthaller W *et al*., 2007).

Non-Conventional Starch Sources

Although, starch obtained from conventional sources has vigorous usage, its extraction from unconventional sources offer an attractive alternative to explore new products with differentiated properties (Santana *et al*., 2017). In addition, an increasing demand for low glycemic index foods paves way for the exploration of starches from unconventional sources. Unconventional sources of starch include fruits (unripe mango, unripe banana, unripe, culled or wasted. Apples, Jackfruit and its seeds, Ramon), Rhizomes (Ginger, turmeric, lotus), cereals (Amaranthas, Millet), Pseudo cereals (Buckwheat), Legumes (Lima bean, Navy bean, Pea, Lentil), Nuts (Horse chestnut, Water chestnut) (Santana and Meireles *et al*., 2014).

The non-edible parts of the unconventional sources comprising seeds, roots, stems, leaves, and bracts are discarded during the industrial processing. High moisture content of these bio-wastes makes them prone to microbial attack resulting in environmental contamination. However, these bio-wastes are a rich source of starch besides housing many bioactive compounds similar to those present in the edible parts including dietary fibers, sesquiterpene, phenolic acids, lactones, flavonoids and enzymes. Based on the global interests in the renewable resources of energy, many investigations have been conducted on recycling and optimization of the industrially important processes for recovery of raw materials, pharmaceutically active biomolecules, and foods, for maximal exploitation of agri-food bio-wastes. Valorization of these bio-wastes may promote their food and nonfood industrial applications (Zayed & Farag *et al*., 2020). An increased demand for starch and enhanced consciousness about valorization of food wastes that can be potential starch sources has pushed researchers to extract and evaluate starch from various unconventional sources which have led to studies on starches from grains, roots, tubers, seeds and even discarded portions of various fruits (Kringel *et al*., 2020). Seeds of Hull-less Barley were evaluated for starch recovery with 58-69 % db. The amylose content ranged from 0-40.3 %, in addition, enzymatic functional efficiency of β glucan was about 77- 90% revealing its efficient separation during processing (Gao, Vasanthan, and Hoover, 2009; Zheng & Bhatty, 1998). Stevenson *et al*., (2006) recovered 44-53 % (db) starch from Apple fruits. Apple starches extracted from unripe apples from

5 different cultivars (Gala, Golden delicious, Granny smith, Jerseymac, Jonagold and Royal Gala) exhibited a CA-type of X-ray diffraction patterns, and a granule diameter of 2 to 12 mm. The apparent amylose content was high (40–48%), compared to the absolute amylose content of 26–29%. The onset temperature, to range between 64 and 66°C, and ΔH of gelatinization varied between16 to18 J/g. In another study Bello-Pérez *et al*., (2006) recovered 34 % starch from Pinhão (Araucaria brasiliensis) Seeds. The starch from this seed exhibited a lower retrogradation with higher consistency than that of corn starch. The starch has higher swelling and solubility in addition to high storage modulus suggesting the possible new applications of this novel starch. (de Barros Mesquita *et al*.,2016) reported the recovery of 70-80% of starch from unripe banana on dry weight basis. The starch granules were found to be oval with a size ranging from 36.58– 47.24 µm. The starch granules exhibited crystallinity pattern type B and the crystallinity index ranged from 31.94-34.06%. Amylose content and resistant starch ranged from 25.13 to 29.01 % and 65.70 to 80.28% respectively.

Lotus is a widely grown aquatic plant grown majorly in China and India (Yu *et al*., 2013). Lotus rhizome and lotus seeds are a potential and major supplier of starch (Showkat *et al*., 2021). Starch from lotus both edible and inedible parts of lotus are extracted widely across the countries where it is cultivated. Several studies have been reported regarding the characterization of lotus starch. As reported by Zhu (2020), Yu *et al*., (2013) and many others, starch granules from lotus rhizome and seeds are of varied sizes, with rhizome starch granules being larger than the granules from seeds, however, the amylase content of the rhizome starch is comparatively lesser (20-25%) than that of the lotus seed starch (25 -35%) and possess C type and A type polymorphs, respectively. The gelatinization and swelling power of rhizome starch is higher than that of the seed starch Man *et al*., 2012; Yu *et al*., 2013) As reported by Liu *et al*., (2015) and Moreira *et al*., (2015), starch content in chestnut fruits range between 42.4% to 53.8% on dry weight basis, thereby effecting the overall quality of the starch extraction in a study done by Guo, Kong and Xu (2019), it was revealed that the total amylase content in chestnut starches ranged between 29 % -42% that is considerably higher than the conventional starches. They also reported that the Peak viscosity, swelling, pasting and thermal properties of chestnut starched varied with different varieties. Size of the chestnut starch granules ranged between 1 to 20µm and are generally oval. They possess strong XRD pattern with typically A type polymorphs and the relative crystallinity of different cultivars range between 19.3 % to 27. 9 %. Resistant starch content ranged between 70 % to 85%, and have medium GI thereby prove to be a significant alternate for diabetics. (Hao *et al*., 2018) Moreschi *et al*., (2006) recovered 40-45 % starch from Turmeric and Ginger tubers, the ginger starch was C type whereas as Turmeric starch was B type. The average granules size of 33 *µ*m was observed. Peak viscosity ranging between 1951-2769 cP and final viscosity of 3045 – 4175 cP at a temperature of 85- 86.5 0C Recovery of starch from baby lima bean has been investigated by (Hoover *et al*.,) 2010, they reported 56-60 % extraction recovery and also found higher amylose content in baby lima beans 32.7 % that remains at par with most of the legumes. The granule size (diameter 17.9 µm) was found to be similar to that of corn starch with heterogeneous and oval shaped morphology. This type of starch finds its application inthe syrups with high glucose contents, also in the baked and canned products that require heating. Lee *et al*., (2007) studied Australian lentil cultivars for the extraction of starch, clean starch 44-45%can be produced from lentil flour and can be used as a functional component in extrusion for development of cereal-based products. Table 2 lists some of the recently evaluated unconventional starch and their recovery yield. Sources such as lotus seeds (Guo *et al*., 2015), litchi (Jaiswal & Kumar, 2015), pinhao (Pinto *et al*., 2015), banana (Bello-Pérez *et al*., 1999; Kaur *et al*., 2020), okenia (Sánchez-Hernández *et al*., 2002), taro (Karmakar *et al*., 2014) and water chestnut (Dularia *et al*., 2019) have been investigated for starch extraction with the current focus being shifted towards isolating starch from unconventional sources.

Table 1: Analysis of the starch obtained from the Non Conventional Sources

Starch Source	Yield (%)	Moisture (%)	Proteins (%)	Lipid (%)	Ash (%)	Carbohydrate (%)	Amylose (%)
Dioscorea sp.	84	12.6	0.08	0.04	0.75	86.5	16.07
Jack fruit seed	17	9.89	0.09	0.03	0.04	89.95	26.4
Mango seed	11.8	10.3	0.18	0.09	0.20	88.63	14
Sweet potato	48	11.76	0.19	0.17	0.24	87.64	21.46
Tapioca	60	12.5	0.04	0.06	0.11	87.29	19.8
Buckwheat	23	10.19	0.07	0.13	0.16	85.23	22.8
Taro	15	11.2	0.04	0.08	0.14	88.54	26.1

CONCULSION

Isolation of starch from non-conventional sources will be helpful for improving the economic value of the underutilized crops. Starch has extended shelf life so post-harvest loss will be reduced and these starches can be utilized for development of various innovative products in pharmaceutical industry.

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