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Starch: An Overview

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ABSTRACT:
One of the most naturally occurring powders or polymers is known as starch which has been till now shown its huge field of application in almost every field of work. Food & beverage industries, cosmetics industries, and pharmaceutical industries use starch as one of the most usable products. Starch is obtained mainly in two different forms conventional method i.e. starch obtained directly from plants such as maize, pea, and wheat, and non-conventional method i.e. starch obtained by extracting from different botanical species such as banana, mango, and jackfruit. Nowadays modern days pharmaceutical sectorsfocuses on targeting drug delivery systemsand shows a keen interest in starch. This review mainly focuses on the origin, application, and characterization of starch.

Keywords: starch, conventional method, non-conventional method, applications, characterizations.

I. INTRODUCTION:

All living things depend on the conversion of carbon and energy; that implies that regardless of whether an organism consumes autotrophic or heterotrophic food, its fundamental metabolism revolves around carbs. The fact that polysaccharides are the most prevalent polymers in the biosphere is therefore not surprising. Starch is the most prevalent storage carbohydrate on Earth in terms of quantity, and it is mostly produced by plants and some cyanobacteria(1,2). While most other species create water-soluble glycogen as a form of storage carbohydrate, starch is accumulated as water-insoluble particles or starch granules (3). Both polymers share the same biological properties and chemical makeup of glucose units connected by 1,4 and 1,6 glycosidic linkages. The great value of starch in many applications is due to the physical characteristics of starch, which differ significantly from those of glycogen (4). Due to its abundance, affordability, non-toxic qualities, and biodegradability for many food and non-food businesses, starch is a flexible biomaterial of particular interest. As a result, it is utilized in a variety of dairy and pastry products, soups and sauces, coatings, and meat products. In addition, the need for starch as a renewable resource is rising in non-food businesses(5).

DIFFERENT SOURCES OF STARCH:

ORIGIN OF STARCH:

Around AD 77–79, Pliny the Elder's Natural History contained the first account of starch extraction (6).In the past around 30000 years ago in Europe,starch grains of rhizome of, Typhus cattails, and Bulrushes cattails, were used as flour groundunder the stones(7).Persians and Indiansuse starch as a thickening agent when making sweet dishes. Whereas the Romanians used starch as a cosmetic product and thickening agent in sauces(8).

A. CONVENTIONAL SOURCES:

B. NON- CONVENTIONAL SOURCES:

Apart from conventional sources nowadays starches are now can be derived from several sources. Each of these starches shows its physiochemical characteristics, which can be used in different fields according to its applications (9).

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USES OF STARCH IN DAILY LIVES:

Starch is such a product that it has been used in everyday daily lives from edible products to pharmaceutical products, and cosmetics. For example, starches derived from riceproved itself as a most desirable product because of its smallest size and shape hence used in all kinds of applications.Apart from these starchesshow a great area of interest in the field of the pharmaceutical field (10)

USES OF STARCH IN THE PHARMACEUTICAL FIELD:

a. Diluents: Starch is added to solid formulations, such as granules, pills, and capsules, as a diluent and to give them bulk. These formulations include a minimal amount of the active component (11). They have been used to plan normalized colorant and potent pharmaceutical pulverizes, as well as to assist in mixing and handling. Local starches are insoluble diluents with a few desirable characteristics, such as a lack of potentially dangerous interactions with the majority of common APIs and excipients, a lack of physiological and pharmacological tests, and dependable physicochemical and practical qualities (12). Although local starch is not very high, some diluents will depend on things like the relative emphasis, plan approach, API characteristics, and other excipients that will be utilized(13).

b. Disintegrants: Starch is the dissolving agent most frequently utilized in the manufacturing of branded and generic medication tablets and capsules. Because starch is a hydrophilic material, it absorbs water, causes swelling, and breaks the tablet up into tiny pieces so that the medication may be released(14). Within the range of 3–25% weight/weight of the granules or tablets, local starch is used as a disintegrant; a typical fixation is 15% weight/weight. Ideal disintegrant action is achieved during granule formation when half of the starch is employed as an endo-disintegrant in the granule mixture and the other half is simply incorporated as an exo-disintegrant into the dried granules(15).

c. Binders: Using the wet granulation process, starch is dispersed in water and when heat is applied, starch gel is generated. This gel may be utilized in tablets and capsules as a binding agent to the other excipients, keeping them together to form granules. The main benefits of wet granulation with starch as a binder are component homogeneity, improved compaction, improved powder density and flow, less dust, adjusted medication release, and the necessary tablet and granule shape. Out of all the recognized and authorized starches, maize starch is the most frequently utilized in granule and tablet formulation technologies. However, recent research has indicated that innovative or modified starches can function as binders and might potentially take the place of corn starch(16,17).

d. Glidants: In the formulation of traditional capsules and tablets, starch, a hydrophilic glidant, can be added at a concentration of 2–10% w/w to improve the flow of powder and granules and to lessen inter-particulate friction(18). A variety of starches, such as corn starch, are usually utilized as glidants in the formation of capsules and tablets. Starches derived from yam, cassava, and fonio have also demonstrated potential as glidants in tablet formulation. The characteristics of starch as a glidant that are assessed in pharmaceutical powders and granules include flow rate, angle of repose, and flow factor(19).

e. Lubricants: To reduce the interfacial friction between the tablet's surface and the die walls, which is necessary for ejection and to keep the granules and tablets from adhering to the punch, lubricants are excipients that are commonly added in small amounts to powders and granules during the formulation of tablets and capsules(20). Starch makes about 2–10% of the weight of the powder and granules. As starch might modify the flow and compaction of the combined powder, sufficient testing must be done to determine an ideal concentration before using it as a lubricant in the formulation of tablets and capsules. Frequently utilized as a lubricant, maize starch BP has two functions: it increases the flow of powder and keeps tablets and granules from adhering to die walls(21).

f. Novel applications: Starch has been employed as a drug carrier for regulated drug delivery, which is a unique application. Due to its mucoadhesive qualities, starch—which are made up of amylose and amylopectin—can be employed as a coating or film-forming

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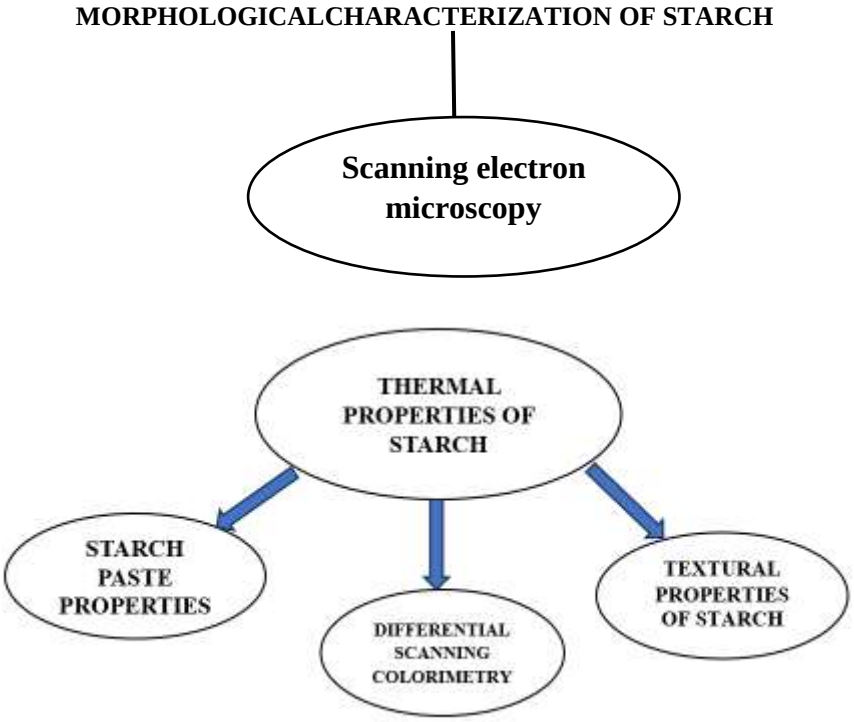
polymer, making it suitable for target delivery and regulating the release of medication from the body(22). Research has shown that maize starch can be a useful film coat for tablets, delaying the rate of dissolution and allowing for regulated drug release. The starch coating can also be incorporated into nanoparticles and the matrix system to deliver the drug to targeted locations such as the colon, lungs, and cancer cells.Starch can be mixed with other polymers including chitosan, sodium alginate, and PVP to enhance its film-forming properties(23). Drug delivery via microspheres has become possible due to the usage of starch as a coating polymer. The characteristics of starch as microspheres in the cross-linking effect are that the particle size increases with an increase in cross-linking time, increasing the concentration of drug loading; the swelling ratio of the particles was determined by the type of cross-linker, not by the length of cross-linking. The protein-drug matrix targeting drug delivery method, which targets the colon with medication, can also employ starch cross-linking(24). When compared to conventional or native starch, the resistant starch exhibits a similar drug release and is thought to be resistant to the intestinal wall's amylase enzyme. However, it does not create nanoparticles, therefore the drug release is faster. Reducing the branch suggests a perfect starting point for ligand conjugation when designing an oral colon-specific nanoparticulate drug carrier(25,26).A variety of techniques, including recrystallization, enzymolysis, acid hydrolysis, cross-linking microemulsion, ultra-sonication, and nanoprecipitation, can be used to create starch nanoparticles. For the transdermal administration of drugs including testosterone, flufenamic acid, and caffeine, starch-based nanoparticles have been used(27). Starch nanoparticles may be used in transdermal drug delivery applications, according on information on skin penetration for the three drugs. When these nanoparticles' elucidation and delivery characteristics were taken into account, they demonstrated high epitome effectiveness for the three tried drugs (flufenamic acid, caffeine, and testosterone); similarly, a nearly straight delivery profile was observed for hydrophobic drugs with an invalid starting burst impact(28-30).

DIFFERENT CHARACTERIZATION PROCESSES OF STARCH:



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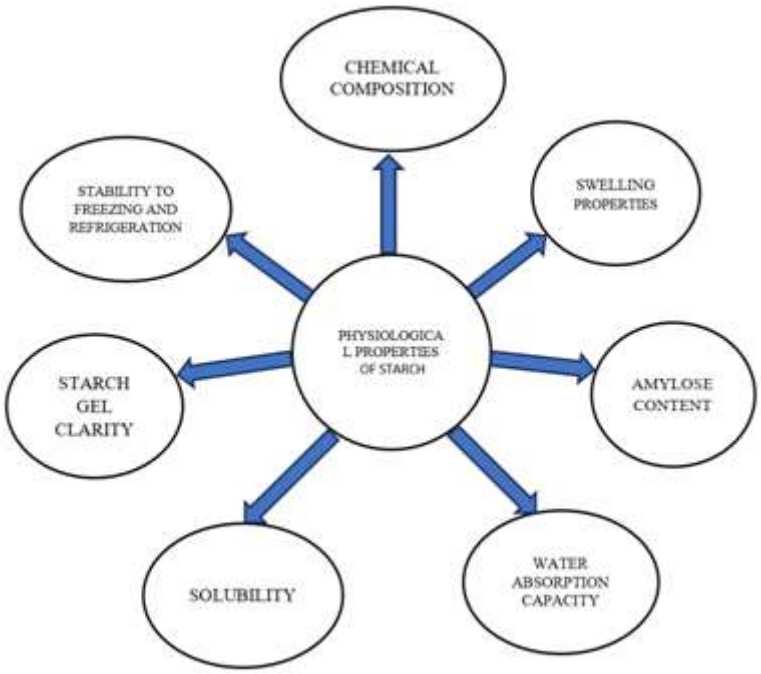

II. CONCLUSIONS:

In our daily lives, starch is a substance we utilize practically everywhere. Powdered starch is a naturally occurring substance that may be produced through both traditional and unconventional methods. Currently, a variety of botanical materials are used as an unconventional source for starch manufacturing. Because of these qualities, starch has a wide range of applications in both household and commercial sectors, including the food and beverage, cosmetic, and pharmaceutical industries. Thanks to nanotechnology, starch is now used in targeted and controlled-release drugs. This indicates that starch was utilized thirty thousand years ago and that the future will be just as a shining star.

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All the authors have equally contributed in this review work and they have shared their ideas equally in different segments of this manuscript, thus the authors are acknowledged as well as I acknowledge their institutions for giving this opportunity for their authorship in this manuscript.

CONFLICT OF INTEREST:

No author shows any conflict of interest according to my knowledge.

REFERENCES:

[1]. U. Cenci, F. Nitschke, M. Steup, B.A. Min assian, C. Colleoni, S.G. BallTransition from glycogen to starch metabolism in Archaeplastida.

[2]. Ardha Apriyanto, Julia Compart, Joerg Fettke, A review of starch, a unique biopolymer – Structure, metabolism and in planta modifications, Plant Science, Volume 318, 2022, 111223, ISSN 0168-9452, https://doi.org/10.1016/j.plantsci.2022.111223.

[3]. Brust H, Orzechowski S, Fettke J. Starch and Glycogen Analyses: Methods and Techniques. Biomolecules. 2020 Jul 9;10(7):1020. doi: 10.3390/biom10071020. PMID: 32660096; PMCID: PMC7407607.

[4]. Compart, J.; Singh, A.; Fettke, J.; Apriyanto, A. Customizing Starch Properties: A Review of Starch Modifications and Their Applications. Polymers 2023, 15, 3491. https://doi.org/10.3390/polym15163491

[5]. S.C. Zeeman, J. Kossmann, A.M. Smith Starch: its metabolism, evolution, and biotechnological modification in plants Annu. Rev. Plant Biol., 61 (2010), pp. 209-234.

[6]. Pliny The Elder; The Natural History (Pliny), Book XIII, Chapter 17,
[7]. Fausto F Dias, Starch: Perspective and Opportunities, Journal of Scientific & Industrial Research, Vol.58, June 1999, pp 403-413.
[8]. Hunter, Dard (1947). Papermaking. DoverPublications. p. 194. (ISBN 978-0-486-23619-3.)
[9]. Yaeel Isbeth Cornejo-Ramírez, Oliviert Martínez-Cruz, Carmen Lizette Del Toro-Sánchez, Francisco Javier Wong-Corral, Jesús Borboa-Flores & Francisco Javier Cinco-Moroyoqui (2018) The structural characteristics of starches and their functional properties, CyTA - Journal of Food, 16:1, 1003-1017, DOI: 10.1080/19476337.2018.1518343
[10]. O. Kunle O. Starch Source and Its Impact on Pharmaceutical Applications [Internet]. Chemical Properties of Starch. IntechOpen; 2020. Available from: http://dx.doi.org/10.5772/intechopen.89811
[11]. Christian Joseph R. Cumagun, in Biotechnology and Biology of Trichoderma, 2014.
[12]. Afrin S, Gupta V. Pharmaceutical Formulation. [Updated 2023 Aug 30]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK562239/.
[13]. Mayuri Phukan, Freddy Teilang Nongkhlaw, STARCH: AN OVERVIEW OF ITS CONVENTIONAL AND UNCONVENTIONAL SOURCES, PHARMACEUTICAL AND INDUSTRIAL APPLICATIONS, STARCH: AN OVERVIEW OF ITS CONVENTIONAL AND UNCONVENTIONAL SOURCES, PHARMACEUTICAL AND INDUSTRIAL APPLICATIONS.
[14]. Manek RV, Builders PF, Kolling WM, Emeje M, Kunle OO. Physicochemical and binder properties of starch obtained from Cyperus esculentus. AAPS PharmSciTech. 2012 Jun;13(2):379-88. doi: 10.1208/s12249-012-9761-z. Epub 2012 Feb 17. PMID: 22350737; PMCID: PMC3364391.
[15]. Fabian, Cynthia & Ayucitra, Aning & Ismadji, Suryadi & Ju, Yi-Hsu. (2011). Isolation and characterization of starch from defatted rice bran. Journal of the Taiwan Institute of Chemical Engineers. 42. 86-91. 10.1016/j.jtice.2010.03.013.
[16]. Builders, P. F., & Arhewoh, M. I. (2016). Pharmaceutical applications of native starch in conventional drug delivery. In Starch/Staerke. https://doi.org/10.1002/star.201500337
[17]. Lestari, P. M., &Pamungkas, S. T. (2019). The Chewable Tablet of Guava Leaves Extract (Psidium guajava L.) with Breadfruit Starch as Binder. JurnalJamu Indonesia. https://doi.org/10.29244/jji.v4i1.87
[18]. Ashika Advankar, Rahul Maheshwari, Vishakha Tambe, Pooja Todke, Nidhi Raval, Devesh Kapoor, Rakesh K. Tekade, Chapter 13 - Specialized tablets: ancient history to modern developments, Editor(s): Rakesh K. Tekade, In Advances in Pharmaceutical Product Development and Research, Drug Delivery Systems, Academic Press, 2019, Pages 615-664, ISBN 9780128144879, https://doi.org/10.1016/B978-0-12-814487-9.00013-2.
[19]. Adjei FK, Osei YA, Kuntworbe N, Ofori-Kwakye K. Evaluation of the Disintegrant Properties of Native Starches of Five New Cassava Varieties in Paracetamol Tablet Formulations. J Pharm (Cairo). 2017;2017:2326912. doi: 10.1155/2017/2326912. Epub 2017 Jul 9. PMID: 28781909; PMCID: PMC5525100.
[20]. G. Moody, M.H. Rubinstein, R.A. FitzSimmons, Tablet lubricants I. Theory and modes of action, International Journal of Pharmaceutics, Volume 9, Issue 2, 1981, Pages 75-80, ISSN 0378-5173, https://doi.org/10.1016/0378-5173(81)90001-6.
[21]. Chonticha Amornrojvaravut, Jomjai Peerapattana, Application of co-precipitated glutinous rice starch as a multifunctional excipient in direct compression tablets, Heliyon, Volume 9, Issue 9, 2023, e19904, ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2023.e19904.

[22]. Lukova P, Katsarov P, Pilicheva B. Application of Starch, Cellulose, and Their Derivatives in the Development of Microparticle Drug-Delivery Systems. Polymers (Basel). 2023 Aug 31;15(17):3615. doi: 10.3390/polym15173615. PMID: 37688241; PMCID: PMC10490215.

[23]. Krogars, K., Antikainen, O., Heinämäki, J., Laitinen, N., & Yliruusi, J. (2002). Tablet film-coating with amylose-rich maize starch. European journal of pharmaceutical sciences : official journal of the European Federation for Pharmaceutical Sciences, 17(1-2), 23–30. https://doi.org/10.1016/s0928-0987(02)00134-3.

[24]. Atyabi, F., Manoochehri, S., Moghadam, S. H., & Dinarvand, R. (2006). Cross-linked starch microspheres: effect of cross-linking condition on the microsphere characteristics. Archives of pharmacal research, 29(12), 1179–1186. https://doi.org/10.1007/BF02969311.

[25]. Zhanggui Wang, Shuli Wang, Qinhong Xu, Qi Kong, Fei Li, Lin Lu, Yibiao Xu, Yali Wei, Synthesis and Functions of Resistant Starch, Advances in Nutrition, Volume 14, Issue 5, 2023, Pages 1131-1144, ISSN 2161-8313, https://doi.org/10.1016/j.advnut.2023.06.001.

[26]. Chen, L., Li, X., Pang, Y., Li, L., Zhang, X., & Yu, L. (2007). Resistant starch as a carrier for oral colon-targeting drug matrix system. Journal of materials science. Materials in medicine, 18(11), 2199–2203. https://doi.org/10.1007/s10856-007-3009-6

[27]. Morán, D.; Gutiérrez, G.; Blanco-López, M.C.; Marefati, A.; Rayner, M.; Matos, M. Synthesis of Starch Nanoparticles and Their Applications for Bioactive Compound Encapsulation. Appl. Sci. 2021, 11, 4547. https://doi.org/10.3390/app11104547.

[28]. Santander-Ortega, M. J., Stauner, T., Loretz, B., Ortega-Vinuesa, J. L., Bastos-González, D., Wenz, G., Schaefer, U. F., & Lehr, C. M. (2010). Nanoparticles made from novel starch derivatives for transdermal drug delivery. Journal of controlled release : official journal of the Controlled Release Society, 141(1), 85–92. https://doi.org/10.1016/j.jconrel.2009.08.012

[29]. Palmer BC, DeLouise LA. Nanoparticle-Enabled Transdermal Drug Delivery Systems for Enhanced Dose Control and Tissue Targeting. Molecules. 2016 Dec 15;21(12):1719. doi: 10.3390/molecules21121719. PMID: 27983701; PMCID: PMC5639878.

[30]. Santander-Ortega, Manuel & Stauner, T & Loretz, Brigitta & Ortega-Vinuesa, J.L. & Bastos-González, Delfi & Wenz, G. & Schaefer, Ulrich & Lehr, Claus-Michael. (2009). Nanoparticles made from novel starch derivatives for transdermal drug delivery. Journal of controlled release : official journal of the Controlled Release Society. 141. 85-92. 10.1016/j.jconrel.2009.08.012.