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Artichoke: Magical Mediterranean Herb and Its Role in Starch Digestion

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Abstract

In addition to being well-known for their taste and culinary diversity, artichokes are important for the breakdown of starches. Artichokes are high in dietary fiber, especially inulin, which helps to support the growth of good gut bacteria and improve digestive health. In addition, artichokes have enzymes like α-amylase and α-glucosidase that help break down starch into simpler carbohydrates like glucose so that it may be absorbed more easily. Artichokes include a substance called cynarin, which increases bile production and enhances the absorption of nutrients overall as well as the digestion of fat. This study highlights the critical function that artichokes play in facilitating effective starch digestion and maintaining healthy digestion by thoroughly examining the biochemical makeup of the vegetable and its effects on the digestive process.

Keywords: Artichoke, Starch digestibility, Secondary metabolites, Bio availability, Gut microbiota

Introduction

Being progressive towards technological era, people flourish with different multifactorial chronic diseases like obesity, cerebrovascular, respiratory and reproductive diseases day by day with high morbidity and mortality. Among the alternative solutions, Phytotherapy has gained a great space it has potential to tackle multifactorial chronic metabolic inflammatory conditions as well as boosting the overall wellbeing. Different medicinal plants have been explored and among which Artichoke (*Cynara sp.)* is an important one.

Artichoke: Magical Herb

Artichoke is a member of *Asteraceae* family famous for its hepato-protective properties, also seems to have an effect as an anti-obese agent. Artichoke is native to Mediterranean Basin. Leading producer countries of artichoke are Italy, Spain, Egypt etc. It

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includes mainly two crops- globe artichokes (*Cynaracardunculus var. scolymus L.)* and cardoon artichokes (*Cynaracardunculus var. altilis DC*).

Globe artichoke

Cardoon artichoke

Artichoke has lots of health benefits like- anti-oxidative, anti-inflammatory, hepatoprotective, cardiovascular protective, cholorectic etc. Secondary metabolites are those metabolites which are not taking part in any important role in primary metabolism in plant system like photosynthesis, respiration etc. Artichoke head and leaf extracts contains several secondary metabolites i.e. polyphenols, terpenoids, dietary fibers which ultimately responsible for those health attributes.

Bio-availability and Bio-accessibility: -

Bioavailability defined as fraction of ingested nutrients that reaches systemic circulation and utilized by our body. It mainly depends on three factors- bio-accessibility, absorption and transformation**.** (Fig. 1)

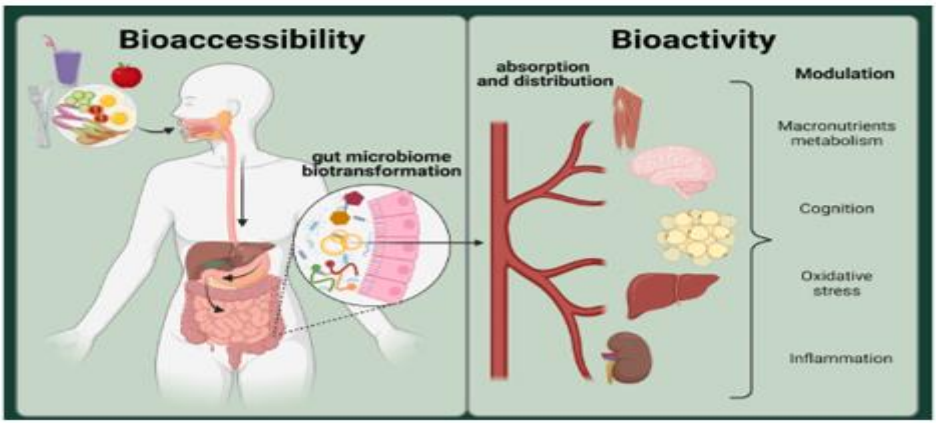

Fig. 1: Bio-availability and Bio-accessibility

- Bio-accessibility is defined as fraction of compound which is released from the food matrix in the gastro-intestinal lumen and thereby made available for intestinal

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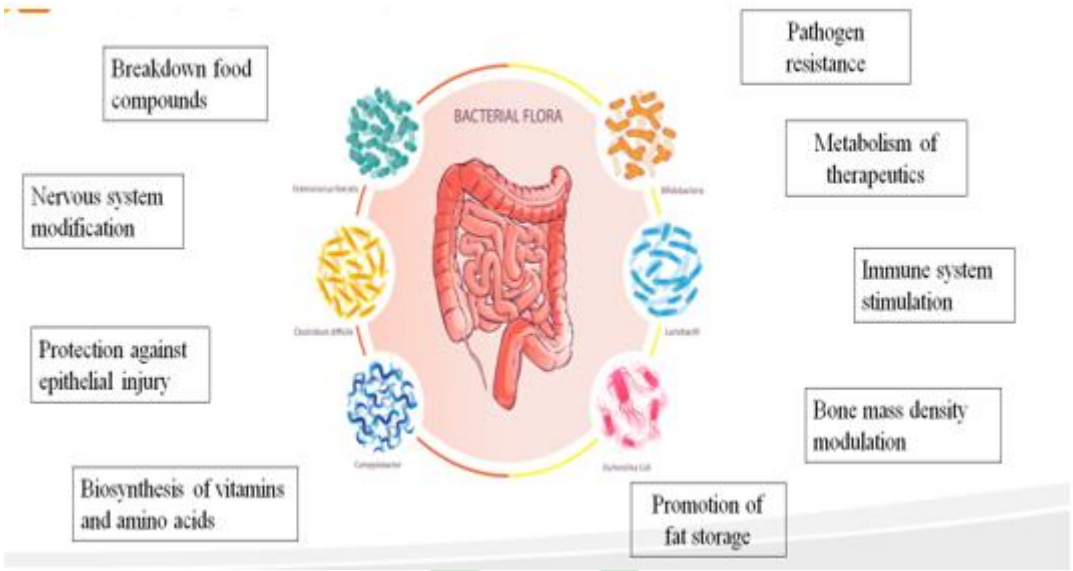
absorption. The factors responsible for these are as follows-Liberation, solubility, physical form, other factors.

- Absorption is defined as how much of biomolecules absorbed into the lumen of gut. Mucous layer, presence of tight junctions, active transport, efflux transporter are important parameters to consider.

Gut-microbiota:

- Gut microbiota (GM) are the microorganisms (generally bacteria and archaea), comprised of largest number of cells (10^E14) in the human body that live in the digestive tracts of humans.
- The gene set of Gut microbiotas (Gut microbiome) is estimated to the about 3 million genes (150 times larger than that of human genome).
- GM can vary according to age, sex, genetic background, immune status, geography, diet, prebiotics, probiotics, living conditions, diseases and drugs.



Fig, 2: Role of Gut microbiota in human health

Predicted Routes of Digestion of Dietary Polyphenols:

The probable rout of digestion of dietary polyphenols described by Kristina B. Martinez *et al.* (2017), initial modifications are induced by gastric acid in the stomach. In the small intestine, they are cleaved to release the glycoside radical before absorption by Lactase phlorizin hydrolase (LPH) and cytosolic β-glucosidase (β-CBG). Some may be cleaved by

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intestinal bacteria to produce small molecules like phenolic acids. Polyphenols can undergo conjugation reactions, adding methyl, glucuronide, or sulfate groups. Remaining structures attached to rhamnose are modified by α-rhamnosidases produced by colonic microflora.

They can follow four pathways:

- Excreted through feces.
- Absorbed by the intestine/colon mucosa, pass through the portal vein, and reach the liver.
- Further conjugated in the liver with methyl, glucuronide, or sulfate groups and released into the bloodstream for tissue absorption.
- Excreted in urine.

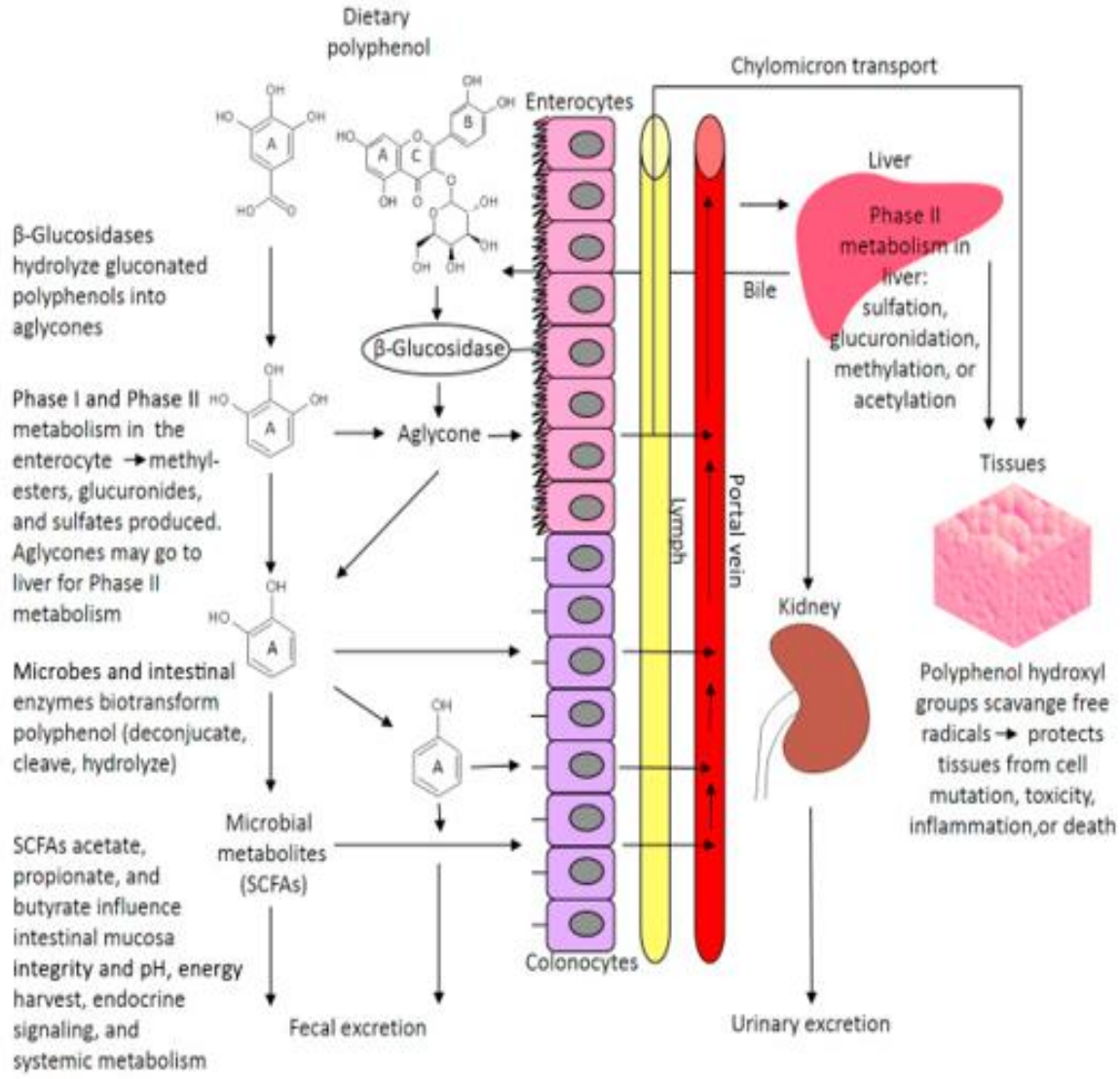

Fig. 3: Routes of digestion of dietary polyphenols

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Starch digestion and SCFA production:

- Rapidly Digestible Starch (RDS): The amount of starch digested and absorbed by enzymes within 20 min during digestion.
- Slowly Digestible Starch (SDS): The amount of starch completely digested from 20 min to 120 min during digestion.
- Resistant Starch (RS): It refers to those starch which still not be digested within 120 min in the small intestine and therefore passes into the large intestine where it can act as fermentative substrate and produces short chain fatty acids (SCFA) like butyrate, acetate, propionate etc which have lots of health benefits in our body.

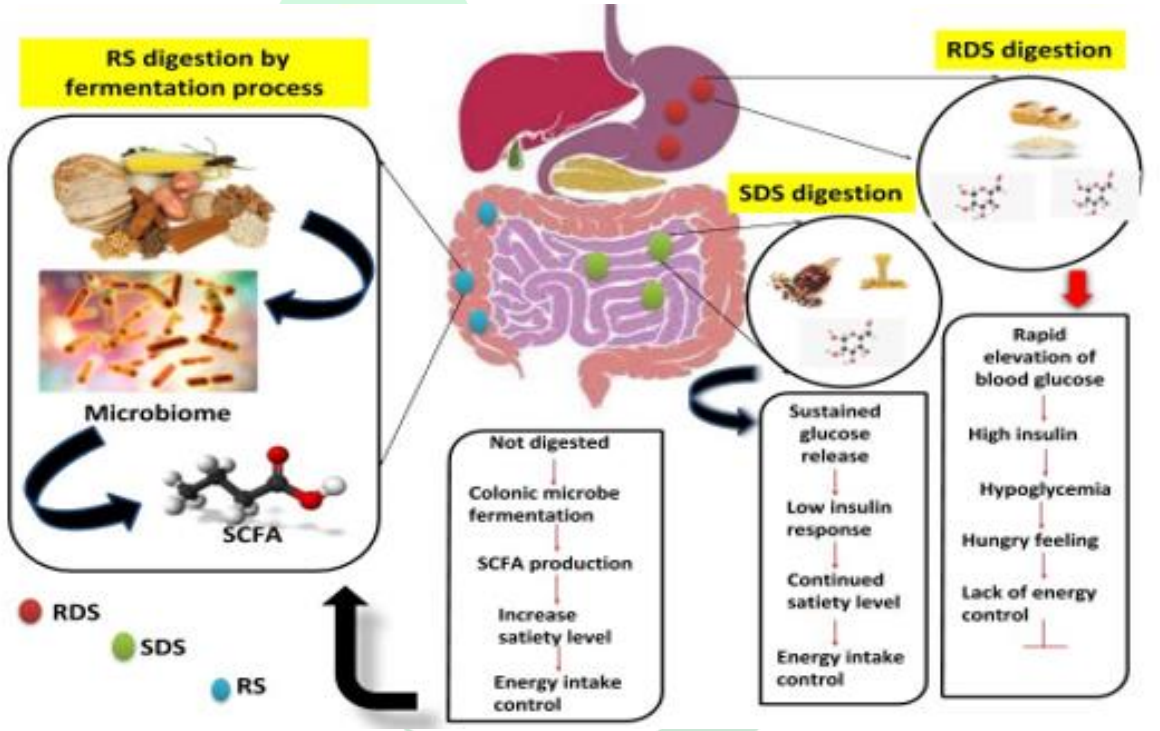

Fig 4: Starch digestion and nutritionally relevant fractions: Role in glycemic response, satiety, energy control and gut health.

Role in Starch Digestion

Gut microbiota (GM) are the microorganisms (generally bacteria and archaea), comprised of largest number of cells (10^E14) in the human body that live in the digestive tracts of humans. The gene set of Gut microbiotas (Gut microbiome) is estimated to the about 3 million genes (150 times larger than that of human genome). GM can vary according to age, sex, genetic background, immune status, geography, diet, prebiotics, probiotics, living

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conditions, diseases and drugs. These microorganism's breakdown food compounds and make them bioavailable as well as bio accessible for gut absorption.

In order to validate the medicinal properties of Artichoke metabolites as well as to understand the metabolic changes that probably happen to the metabolites in the gastrointestinal system on oral consumption, Rocchetti *et al.*, (2020) conducted certain *in vitro* studies such as; starch digestibility, bio accessibility, gut bioavailability, intestinal fermentation, etc. The bud extracts before and after *in vitro* studies were analyzed using LC-MS coupled with multivariate statistical model and found a broad spectrum of differences in bio accessibility as well as bioavailability of compounds belong to different classes of secondary metabolites.

The results of *in vitro* digestibility studies showed that, anthocyanin (14.2%) and flavones (13%), followed by lignans (7.7%) were the higher in percent as bio accessible compounds, whereas sesquiterpene lactones (1.6%) and phenolic acids (1.6%) found as the lowest in the lumen of the gastrointestinal tract. Possible reason for the observed highest percent bioavailability values for sesquiterpene lactone (82.4%), followed by flavan-3-ols (71.6%) and phenolic acids (67.6%) were that they could be easily transported through the intestinal Caco-2 monolayer. Therefore, metabolomics on *in vitro* digestion and fermentation has highlighted that, only a limited portion of the initial amount of Artichoke extract become bio accessible in the large intestine (Colantuono *et al*., 2018)

In summary, only a limited portion of the initial amounts become bio-accessible in the large intestine. Phenolics followed an extensive transformation during the digestion and fermentation processes, resulting in the appearance of lower molecular weight compounds. Caco-2 bio-availability assays allowed recording good bioavailability values, in particular for sesquiterpene lactones and lower molecular weight phenolics.

Future Perspectives:

- There is still need of study for modifications of polyphenols during stimulated gastrointestinal processes and especially on the factors potentially influencing their bio-accessibility/bio-availability.
- This study mainly highlights only bio-accessibility/bio-availability for polyphenols and sesquiterpene lactone, but in reality, other factors are also taking leading role for modulating bio-accessibility/ bio-availability of this process.

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- In Caco-2 models, only sesquiterpene lactones and low molecular weight polyphenols are recorded good bioavailability, so *in-vivo* confirmations are always recommended for better understanding.
- As the resistant starch amount increased with the amount of AE, it will reduce the rate of glucose release into the blood. This principle could be used as a Phytotherapy & production of anti-diabetic drugs and it would be helpful for obese patients.

Conclusion:

Therefore, to support the *in vitro* results, *in vivo* confirmatory trials need to be conducted and that could, provide useful insights into the importance of digestion and fermentation processes of bioactive phytochemicals in phytotherapy. Phytotherapy would gain a great space as it has potential to tackle multifactorial chronic metabolic inflammatory conditions as well as boosting the overall well- being.

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