Review Article

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Impact of Heat on Naturally Present Digestive Enzymes in Food

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Abstract

Enzymes are dissolution large complex molecules like proteins, carbohydrates, and fats into smaller ones. They are secreted by the salivary glands and gastric mucosa of the stomach, pancreas, and small intestine, also present in many fruits and vegetables in significant amounts. The objective of this study was to review the available literature on the naturally available enzyme on food like fruits and vegetables and the impact of heat on their activity. Foods that contain natural digestive enzymes include pineapples, papayas, mangoes, bananas, avocados, kiwifruit, and ginger indicating that enzyme disintegration is influenced by temperature. The optimum temperature for protease activity of kiwifruit, papaya, zinger, and pineapple was at 40 degrees Celsius (^{o}C) and active between 8 to 70°C. Amylase of banana, mango has been testified to activity between 8°C and 38°C and the optimum temperature was 30, starting to be denatured at 38°C and being fully denaturized after 5 minutes at 100°C. The Avocados lipase was active in the temperature ranging from 5 to 65°C and the optimum temperature for lipase action was observed to be 37°C.

Keywords: Digestive enzymes; Natural enzymes; Food enzymes; Digestion; Optimum temperature.

INTRODUCTION

Digestive enzyme activity is intricate in the regulation of growth performance because digestive enzymes act by absorption to improve feed efficiency and in turn modify the process of nutrient metabolism.[1] Digestive enzyme are essential for this process, as they break down molecules like fats, proteins, and carbs into even smaller molecules that can be easily absorbed.[2] There are three main types of digestive enzymes: **(*I*)** ***Proteases:*** Break down protein into small peptides and amino acids **(*II*)** ***Amylases*****:** Break down carbohydrate like starch into simple sugars **(*III*)** ***Lipases:*** Break down fat into three fatty acids plus a glycerol molecule. Enzymes are also made in the small intestine, including lactase, maltase, and sucrase.[3,4] If the body is unable to make enough digestive enzymes, food fragments cannot be digested properly.[5] This can lead to digestive illnesses like lactose intolerance. Thus, eating foods that are rich in natural digestive enzymes can help improve digestion.[6] The objective of this study was to review the available literature on the naturally available enzyme on fruits and vegetables. The study of the field shows that digestive enzymes can be obtained naturally through foods. A well-balanced diet that contains fresh fruits and vegetables, lean proteins, and whole grains.[7] These foods will certainly help support the work digestive enzymes are already doing. Adding any of these

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foods to the diet may help promote digestion and better gut health. Enzyme activity can be influenced by a variety of aspects, such as temperature, the potential of hydrogen (pH), and concentration.[8] Enzymes work best within specific temperature and pH ranges, and sub-optimal circumstances can cause an enzyme to be unable to find its capability to bind to a substrate. These enzymes found in fruits and vegetables are also affected by temperature,[9] so it becomes necessary to assess the effect as well as optimum temperature for activity.

METHOD

A consolidative review of the literature was carried out before January 2022. Applicable articles were identified by applying search strategies to six academic electronic databases: PubMed, Scopus, SpringerLink, Article First, Wiley Online, and Science-Direct. Search terms and keywords included: Proteases, Lipases, Amylases, Digestive enzymes, the enzyme in fruits and vegetables. All retrieved titles, abstracts, and full-text publications were studied and screened for importance to the topic. Furthermore, references from retrieved articles were reviewed to identify additional applicable publications. In this research, the paper study was included within 10 years of the publication on the relevant field.

RESULTS

Digestive enzymes are proteins that break down larger fragments like fats, proteins, and carbs into smaller particles that are easier to absorb across the small intestine.[10] Without enough digestive enzymes, the body is incapable to digest food particles properly, which may lead to food intolerances.[11] Significant fruits, such as pineapples, mango, papaya, ginger, kiwifruits, and oranges contain natural digestive enzymes that determine their quality.

(*I*) *Proteases:* Protease enzyme catalyzes proteolysis, breaking down proteins into smaller polypeptides or basic unity of amino acids, and encouraging the formation of novel protein products.[12] They do this by smiting the peptide bonds within proteins throughout hydrolysis, the reaction where the water breaks bonds. Fruits like papaya, kiwifruit, pineapple, and figs all contain enzymes named proteases. Proteases speed up the dissolution of proteins.[12] Kiwifruit showed the highest protease activity appeared in the temperature range of 50–60 degrees Celsius (°C), depending on the fruit extract.[13] The optimum activity of crude protease extract was found at pH 7.0 and 50°C.[14] The crude protease enzyme was highly stable stability at temperatures below 40°C. When based on the overall reviewed data, the enzyme's activity of fruit protease showed activity at a temperature of 40°C to 70°C and the optimum temperature was 50°C.

Kiwifruit: The kiwifruit is an edible berry that is often suggested to ease digestion.[15] It's a great source of digestive enzymes, particularly a protease called actinidin. This enzyme supports digest proteins and is commercially used to tenderize tough meats. Moreover, kiwifruit contains many other enzymes that support ripening the fruit.[16] Researchers believe actinidin is one reason why kiwifruits seem to relieve digestion. An animal study found that adding kiwifruit to the diet enhanced the digestion of beef, gluten, and soy protein divorces in the stomach.[12] This was thought to be due to its actinidincontent.[16] Another animal study analyzed the effects of actinidin on digestion.[14] It fed some animals kiwifruit with active actinidin and other animals kiwifruit without active actinidin. Results exposed that animal-fed kiwifruit with active actinidin digested meat more proficiently. The meat also stimulated faster through the stomach.[17] Numerous human-based studies have also found that kiwifruit aids digestion, decreases bloating, and helps relieve constipation.[18]

In the case of proteolytic enzymes in kiwifruit, the maximum value of protease activity was observed at 50°C and sustained its activity up to 70°C.[19] The optimal temperature for the enzyme (actinidin) activity extracted from kiwifruit has been testified to be approximately 58°C to 62°C, and bromelain, which belongs to the cysteine plant proteinases that are known to attack myofibrillar proteins, has an optimum temperature range of 60°C to 70°C.[20]

Ginger: Ginger has been a portion of cooking and traditional medicine for thousands of years.[21] Some of ginger's impressive health benefits may be attributed to its digestive enzymes. Ginger covers the protease zingibain, which digests proteins into their building blocks.[22] Zingibain is used commercially to make ginger milk curd, a popular Chinese sweet course. Unlike other proteases, it's not often used to tenderize meats, as it has a rapid shelf life.[23] Food sitting in the stomach for too long is often thought to be the cause of indigestion. Studies in healthy adults and those with indigestion illustrate that ginger aided food move faster through the stomach by encouraging contractions.[24] Studies on animalshave shown that spices, including ginger, helped increase the

body's creation of digestive enzymes like amylases and lipases. What's more, ginger appears to be anauspicious treatment for nausea and vomiting.[25]

The protease displayed optimum activity at 60°C and pH 6 to 8, respectively.[20] The result obtained is similar to the findings of those who reported that ginger protease exhibited broad optimal proteolytic activity from 40 to 60°C and lost its activity when the temperature increased to 70°C.[26] According to another researchzingibain exhibits a maximum turnover rate at 60°C and rapidly denatures at 70°C. Proteolysis is largely unhampered during cooking with ginger.[27] Optimal temperature ranges of papain and ficin are elevated relative to zingibain, whereas bromelain operates at a somewhat lower range.[8]

Pineapple: Pineapples are a wonderful tropical fruit rich in digestive enzymes.[2] In particular, pineapples comprehend a group of digestive enzymes called bromelain.[4] These enzymes are proteases, which break down protein into its building blocks, including amino acids. This aids the digestion and absorption of proteins.[5] Bromelain can be obtained in powdered form to help tenderize tough meats.[28] It's also generally available as a health supplement to support people who struggle to digest proteins.[29] A study on people with pancreatic insufficiency, a condition in which the pancreas cannot make enough digestive enzymes initiate that taking bromelain combined with a pancreatic enzyme supplement enhanced digestion additional than the enzyme supplement alone.[30] According to a study on the enzymatic activity of bromelain decreased gradually from 25°C to 95°C. Complexed bromelain was unchanging inactivity to heating up to 85°C.[31]Bromelain polyphenol complex showed a good heat resistance.[30] The result exposed that polyphenol could protect bromelain in pineapple juice from heat denaturation.[28] Bromelain from pineapple stems is completely inactivated by heating for 30 min at 60°C; initiate that bromelain retained 50% of its activity level after 20 min heating at 60°C.[30]

Papaya: Papaya is a tropical fruit rich in digestive enzymes proteases that help digestion of proteins.[4] However, they contain a diverse group of proteases recognized as papain. Papain is also available as a meat tenderizer and digestive supplement.[32] Studies have exposed that taking a papaya-based method may help ease digestive symptoms of irritable bowel syndrome, such as constipation and inflating.[33]

Heat exposure can destroy their digestive enzymes also,[32] unripe or semi-ripe papayas can be unsafe for pregnant women, as they may stimulate contractions.[34] Papain has an best temperature of 65°C and denatures at around -13°C and 85°C (Papain).[35] However, if the temperature of papain goes beyond 65°C, then the rate of reaction will reduce as the temperature increases.[36]

Fig: Fig has a digestive enzyme existing called ficin, classified as a thiol protease.[3] It helps in nourishing the digestive tract which returns helps in digesting food rapidly. An important key to losing weight as well as tumblingabdomen fat by keeping a healthy digestive system. It comprehends a reactive cysteine in its dynamic part. There was no significant difference in ficin activity at the incubation temperatures of 40°C and 50°C, as well as 60 °C and 70°C.[37] Nevertheless, comparisonof the incubation temperatures of 40°C and 50°C with treatment 60°C and 70°C exposed a significant difference in ficin enzyme action.[38]

(*II*) *Amylase*: Theycover the digestive enzymes amylases are a group of enzymes that break down carbohydrates from starch (a complex carbohydrate) into glucose and maltose.[1,6] Amylase enzymes are correspondingly made by the pancreas and salivary glands.[3] They help break down carbohydrates so that they are simply absorbed by the body.[1] That's why it's often suggested to chew food carefully before swallowing, as amylase enzymes in saliva help break down carbohydrates for relaxed digestion and absorption. For instance, Pineapples naturally contain liquid acid amylase and amyl-glucosidase as an enzyme, which renovates starch to sugar maltose whereas proteases convert proteins into amino acids.[9]

***Mango*:** Mangoes contain the digestive enzyme amylase, which breaks down carbohydrates from starch (complex carbohydrates) into sugars like glucose and maltose.[6] Amylase also helps mangoes ripen. Amylase enzymes are too made by the pancreas and salivary glands. They support breaking down carbohydrates so that they are effortlessly absorbed by the body.[8] That's why it's often suggested to chew food thoroughly before swallowing, as amylase enzymes in saliva help break down carbohydrates for easier digestion and absorption.

Heat Sensitive Enzyme(HSE) was first screened in fresh mango flesh of the variability Samar Bahisht, Chaunsa.[38] Later, the combined effect of different drying temperatures (40 °C, 50 °C, 60 °C, 70 °C, and 80 °C) on the active retention of HSE in dried mango slices of the varieties Sindri, Samar Bahisht, Chaunsa, and Tommy Atkins was investigated.[39] Drying at higher temperatures with a high air

velocity caused a severe reduction of enzyme activity. Some study recommends anappropriate temperature and air velocity to reduce enzyme destruction in dried mango products.[18]

Results of some studies showed that the extreme amylase and invertase activity for dried mango of all three varieties was best preserved in samples dried at a temperature of 80°C.[38] In addition, the correlation of enzyme activity with changes in heat-sensitive nutrients of mango during convective drying and the influence of maturity on enzyme activity needs to be investigated and the optimum temperature for amylase activity was 50-60 °C.[39]

Banana: Bananas fruit have encompassed natural digestive enzymesamylases and glucosidases, two groups of enzymes that break down complex carbohydrates like starch into smaller and more effortlessly absorbed sugars.[9] Due to enzymes breaking down starch into sucrose as bananas start to ripen, ripe yellow bananas are much sweeter than unripe green bananas.[16] Two-month research in 34 women looked at the connection between eating bananas and the growth of healthy gut bacteria. Women who ate two bananas every daypracticed a modest, non-significant rise in healthy gut bacteria. Nevertheless, they did experience significantly less bloating.[29]

The amylase research, which was very stable at 4°C, hydrolyzed soluble potato starch and banana starch at similar rates.[40] Maximum activity was observed between pH 6-7. Amylase was fairly active up to 62°C but fast lost activity above this temperature. There was an approximately twofold upsurge in amylase through the initial phase of ripening. Exactly, α-amylase isolated from banana pulp has been testified to present an optimum activity between 8°C and 38°C, starting to be denaturized at 38°C and being fully denatured after 5 minutes at 100°C.

(*III*) *Lipase:* [3]Lipase is a type of protein made by the pancreas, that assistances the body digest fats. Lipase is an enzyme that catalyzes the hydrolysis of fats and[5] subclass of the esterases. Lipases perform important roles in the digestion, transport, and processing of nutritional lipids in most, if not all, alive organisms.

Avocados: Contrasting other fruits, avocados are exceptional in that they are rich in healthy fats and digestive enzyme lipase.[36] This enzyme helps digest fat molecules into smaller molecules, such as fatty acids and glycerol, which are easier for the body to absorb.[12] However, taking lipase avocados can help comfort digestion, especially afterward a high-fat meal.Avocados also contain other enzymes, including polyphenol oxidase.[40] This enzyme is accountable for turning green avocados brown in the attendance of oxygen. Studies have shown the enzyme extract from avocados had an optimum lipase activity temperature of 36 °C and pH 6.[41]

Orange: The occurrence of lipases was experiential in three byproducts of orange juice processing: peel, core, and frit.[15] It is not directly present in the pulp, it has to be separated from the peel, which requires processing.[42] The orange lipase comes out as a byproduct of orange and the optimal temperature for the action of these byproducts showed a wide range at 20 °C to 70 °C, representative fairly high thermostability.[43]

CONCLUSION

Pineapples contain a group of digestive enzymes called bromelain; papayas contain the digestive enzyme papain booth helps in the breakdown of proteins into amino acids. Mangoes and bananas contain amylase and bananas contain amylases and glucosidases which break down complex carbohydrates into simple carbohydrates like glucose and maltose. They are more active as bananas and mangoes start to ripen. Avocados contain the digestive enzyme lipase, which breaks down fat molecules into smaller fatty acids and glycerol. Kiwifruit contains the digestive enzyme actinidin, which helps digest proteins. Gingerincreases the body's production of digestive enzymes like amylases and lipases. Literature shows that high heat can destroy digestive enzymes and most digestive enzymes show optimum temperature from 30 to 50. Protease of kiwifruit, papaya, zinger, and pineapple activity temperature was 40°C to 70°Cand the optimum temperature was 50°C. Avocados lipase was active in the temperature ranging from 5 to 65°C and the optimum temperature for lipase action was observed to be 37°C. Amylase isolated from banana pulp has been testified to present an optimal activity between 8°C and 38°C, starting to be denatured at 38°C and being fully denaturized after 5 minutes at 100°C and the optimal temperature for amylase action was 50-60 °C.

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