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Aarti Malhosia[1]* and Anjali Shukla[2]

[1]Department of Home Science, Government Girls College Nodal, Vidisha, M. P., India
[2]Department of Home Science, Govt. MLB Girls P.G. Autonomous College, Bhopal, M. P., India

Email: aartimalhosia86@gmail.com

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Aarti Malhosia[1]* and Anjali Shukla[2]

[1]Department of Home Science, Government Girls College Nodal, Vidisha, M. P., India
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Email: aartimalhosia86@gmail.com

ABSTRACT

The pivotal role of amylase-rich foods, particularly in aiding digestion and potentially managing glucose levels, has sparked interest in the scientific community. This paper presents an exploratory study into the potential health effects of making high-solid gruels, a common staple in numerous cultures all around the world, with amylase-rich flour (ARF) generated from wheat and barley. The effects of ARF on the digestibility and glycemic index of these gruels are investigated using both in vitro and in vivo techniques in this study. The findings show that the addition of ARF significantly improves the digestibility of these high-solid gruels, demonstrating an effective conversion of complex carbs into simpler sugars. Additionally, it appeared that the glycemic index of these gruels had decreased, pointing to a potential function for ARF in glycemic management.

Childhood nutrition is a fundamental determinant of health outcome especially among vulnerable populations such as children from tribal and low-income communities. Furthermore, the potential for ARF to increase nutrient absorption and thus contribute to overall growth and development is highlighted, which is of utmost importance in these resource-limited settings.

The paper also posits potential wider implications for public health, particularly in regions where wheat and barley-based gruels are dietary staples and emphasizes the promise of ARF as a cost-effective nutritional intervention to enhance the dietary quality of children in tribal and low-income communities and providing a significant advancement in the pursuit of health equity and improved child health outcomes. These findings advance the nexus between nutritional research and public health by highlighting the health advantages of ARF while also offering considerable support for its promotion in food policies and practices.

Keywords: *Amylase-rich flour (ARF), Glycemic Index, Gruel, Children, Germination etc.*

INTRODUCTION

Porridge made from cereals or cereal flour is typically the first food offered to a child's diet in developing nations. Due to their dense consistency and small energy density per unit volume of food, these porridges force children to eat frequently in order to achieve their daily energy needs. In tribal, rural, or urban slum regions where moms labor the entire day away from home, this is not practical.

Amylase is an enzyme known for its important role in the human body, especially in the digestive process. Amylase, a type of hydrolase enzyme, is crucial for breaking down starch, a polysaccharide, into smaller carbohydrates such as maltose and glucose. This enzyme activity is an integral part of nutritional mechanism, allowing to extract the energy needed for various bodily functions. The role of amylase, produced by salivary glands present in mouth and pancreas, for breaking down carbohydrates- starch into simple sugars that are easily absorbed by the body. This enzymatic activity transforms long-chain complex carbohydrates into shorter-chain molecules such as maltose and glucose, facilitating digestion and assimilation of nutrients.

Amylase is not only found naturally in the human body, but is also found in various foods that contain significant amounts of amylase include fruits such as bananas, especially when they are ripe, and certain grains, vegetables and legumes. For example, ripe bananas and mangoes are high in amylase. Raw fruits, certain types of mushrooms, and sprouted seeds and legumes also contain amylase. In the case of cereals such as wheat and barley, the production method can affect the activity of the amylase enzyme. When these grains germinate, amylase activity increases significantly. Also known as malting, this natural fermentation process is often used in the brewing and baking industries. Amylase-rich flour (ARF) is flour obtained from grains such as wheat and barley that have been treated with high amylase activity. When used in cooking, this flour can improve the digestibility of food, making it useful for people with special dietary needs. As the role of nutrition in health

*Author for correspondence

and well-being is increasingly recognized, there is increasing interest in ARF and its potential health effects.

Human body naturally produces amylase in two main places: the salivary glands and the pancreas. Salivary amylase, also known as ptyalin, begins the digestion process in the mouth even before food reaches the stomach. Salivary amylase converts it into dextrin and maltose, acting on cooked or processed starch, which initiates carbohydrate digestion. Pancreatic amylase, released in the small intestine, continues this process by breaking down carbohydrates into simple sugars that can be absorbed. Foods can also be sources of amylase, and those foods that contain amylase can further aid digestion. Grains are another important source of amylase, especially if they undergo the germination or malting process. During germination, the seed activates various enzymes, including amylase, to break down stored starch into sugars that provide energy for the growing plant. This elevated enzymatic activity persists even after germination, leading to increased amylase content in grains and grain products. Amylase-rich flour (ARF), flour derived from grains such as wheat and barley that have been processed to maintain high amylase activity. Creating ARF typically involves malting or grains are germinated, then dried and ground into flour.

ARFs are the germinated cereal flours that are high in the alpha-amylase enzyme. The majority of a diet centered on cereal is liquefied and reduced by even little amounts of these items. As a result, ARFs assist in both lowering the bulk and raising the calorie density of weaning gruels. To improve the digestion of the inexpensive weaning foods made at home, mothers might add ARF. ARF preparation is relatively easy and is something mothers may do from home.

The resulting ARF not only contains abundant amylase, but also other nutrients released or enhanced during the germination process. These can include vitamins, minerals, antioxidants and fiber, which contribute to the overall nutritional value of ARF. The potential benefits of ARF extend beyond its direct nutritional value. Because it is rich in amylase, foods made with ARF can improve digestion. The amylase in ARF affects starch in food and breaks it down into simpler sugars, even during cooking. Therefore, consuming foods made with ARF can potentially reduce the digestive burden on the body, especially for those with weakened digestive systems. This makes ARF an area of interest for those investigating nutritional interventions for gastrointestinal health. Additionally, because amylase breaks down complex carbohydrates into simpler sugars, ARF may also be involved in controlling the glycemic response to food. Foods made with ARF have a lower glycemic index (GI), a metric used to describe how quickly meal increases blood sugar. A lower GI diet may benefit people who have or are at risk for type 2 diabetes, which is characterized by poor blood sugar control as well as cheapest alternative for children feed over other readymade alternatives.

The time, space, and labor required to produce the mix were, however, the primary limitations in extending the technology to the community level. For, its high amylase content, it was claimed that adding 5% of malted barley might significantly decrease the texture of a 15 percent hot paste slurry of readily available weaning foods including Nestum, Cerelac, Balamul, and Farex [1,2]. So, a number of lab research were conducted in an effort to find a solution for the dietary bulk issue. A 10% (weight per volume) a slurry of malted mix had a much lower cooked-paste viscosity than its roasted counterpart, according to studies on fully roasted and malted mixes. [3]

Based on that premise, Gopaldas et al. produced an amylase-rich food (ARF) from bajra (Pennisetum typhoideum) that significantly reduced the viscosity of a 10% rice gruel when added at a level of 4 g% (weight / weight of total solids) [3,4]. Although malting was required for the ARF's manufacture, it was a technology that could be applied at the community and household levels because the ARF was only needed to thin the gruels in very modest quantities. The bajra ARF showed poor amylase activity, however, and was unable to reduce the consistency of slurries with solid concentration more than 10% since it had undergone high temperature processing. Therefore, the goal of the current study was to create an ARF from wheat with the highest amylase activity and to analyze its impact on wheat-based gruels with increasing solid contents (up to 25%). The reason wheat was chosen is that it is the most widely grown crop in India, is widely consumed outside of a few tribal areas, and is readily available.

2. Producing Amylase-Rich Flour (ARF) from Wheat and Barley

This process involves several steps to increase the grains enzymatic activity and convert them into flour. First step involves selection of high-quality wheat and barley grains. Quality is crucial as it can influence the amount of amylase that can be produced in later stages. After that selected grains are soaked in water for a certain period. This soaking step initiates the germination process in the grains. The water temperature and soaking duration may vary, but it's generally done at room temperature for about 24 hours. Third step includes the process of germination. After soaking, the grains are spread out in a thin layer and allowed to germinate. During germination, the grains naturally produce amylase to break down their starch reserves into simple sugars to fuel the growth process. This period may last for a few days to a week, and it's important to maintain proper moisture and temperature conditions to support germination. Once a satisfactory level of germination has occurred, it's necessary to halt the process to preserve the amylase content. This is often done by drying the grains. They can be air-dried or kiln-dried, but it's important to ensure that the drying temperature is not so high that it denatures the enzymes. After milling malted grains, are ready, they are milled or ground into flour. Depending on the desired texture, the grinding process can result in either a fine or coarse flour.

3. Sources and Chemistry behind Amylase Rich Foods

Sources

Foods rich in amylase include:

1. Raw fruits and vegetables: A kind of amylase known as "ptyalin" is present in raw fruits and vegetables. Bananas, carrots, radishes, and potatoes are some of them.
2. Sprouted grains: Sprouted grains contain more enzymes, such as amylase. Amylase can be found in foods like sprouted wheat, barley, or other whole grains.
3. Fermented foods: Fermentation can also boost the number of enzymes in food, such as amylase. Amylase is present in abundance in foods like sourdough bread, kimchi, sauerkraut, and other fermented vegetables.
4. Honey: It is known that raw honey and bee pollen include a variety of enzymes, including amylase.

Chemistry of Amylase:

Dextrin, maltose, maltotriose, and a-D-glucose are produced when the protein enzyme amylase catalyzes the hydrolysis of internal a-1,4-glycosidic bonds in starch. Amylase performs best between a particular pH and temperature range. Human salivary amylase performs best at a pH range of 6.7 to 7.0, but pancreatic amylase performs best in the small intestine's alkaline environment [6].

Amylase comes in two primary categories:

a) amylase, also known as alpha-amylase. It results in the formation of maltotriose and maltose from amylose or maltose, glucose, and "limit dextrin" from amylopectin by randomly breaking down long-chain carbohydrates along the starch chain.
b) amylase, or beta-amylase. Prior to germination, this enzyme is present in an inactive state, and it becomes active during sprouting. It operates from the polymer's non-reducing end and gradually separates two glucose units at a time into maltose units.

The temperature, pH, and presence of specific chemicals can all impact the enzymatic activity of amylase, which means that how food is prepared, cooked, and kept can change how much amylase is present in it. For instance, cooking frequently renders these enzymes inactive. As a result, foods that have undergone little processing or are uncooked may have more amylase.

4. The Benefits and Risk of Amylase-Rich Flour (ARF)

Benefits of ARFs

The high concentration of amylase, an enzyme that is naturally occurring predominantly linked to the breakdown of starches, gives Amylase-Rich Flour (ARF) its distinctive features. Understanding amylase role in human digestion and how it interacts with different dietary components is the basis of the research underlying ARF and its possible health benefits. In the human digestive tract, amylase enzymes play a significant role. They are made in the pancreas and salivary glands and convert complex carbohydrates, particularly starches, into less complex sugars like maltose and glucose. This enzymatic process is essential for transforming the stored energy

in meals into a form that our bodies can easily utilize. In essence, amylase begins the digestion of carbohydrates in the mouth and continues it in the small intestine.

High amylase concentrations in the context of ARF have two important effects. It helps with digestion, to start. When food prepared with ARF is eaten, the amylase in the flour starts to break down starch into more easily digested sugars. Pre-digesting food might make it easier to digest it once it reaches the digestive tract, which may lessen digestive discomfort, especially in people with impaired digestion.

Second, the way amylase breaks down carbohydrates in food may have an effect on that food's glycemic index (GI), which is a gauge of how quickly a food causes blood sugar levels to rise. The amylase in ARF may contribute to a less abrupt delivery of glucose into the blood stream when the food is taken, possibly resulting in a lower glycemic response. It does this by dissolving complex carbs into simpler sugars. People who are striving to control blood sugar levels, such as those who have diabetes or prediabetes, may find this quality to be especially helpful. Additionally, germination is a step in the process of making ARF that can improve the nutritional profile of the flour by increasing the availability of the additional nutrients in the grains.

Possible Risk of consuming ARFs

Even though eating meals high in amylase generally offers numerous advantages, especially in terms of digestion and nutrient absorption, it's crucial to be aware of any possible hazards. It's important to remember, though, that most people rarely suffer negative consequences from eating meals high in amylase. Some diseases are typically linked to excessive intake or certain medical conditions:

a) Digestive Issues: Such as diarrhea, stomach cramps, and bloating, may result from eating too many foods high in amylase. This is so that the digestive process can be sped up by amylase, which aids in the breakdown of complex carbs into simpler sugars.
b) Blood Sugar Levels: While amylase's role in converting carbohydrates into sugars helps with digestion, it has the potential to cause blood sugar levels to rise, especially in persons who already have diabetes or prediabetes [10-12].
c) Allergies: Certain foods that are high in amylase, such as wheat or other grains, may cause allergies in some people. In such circumstances, eating certain foods might cause adverse reactions.
d) Pancreatic Conditions: People who have certain pancreatic diseases, like pancreatitis or pancreatic cancer, are at risk. A pancreatic issue may be indicated by high levels of amylase [8].
e) Celiac disease or gluten sensitivity: Several foods, including wheat and barley, that are rich in amylase also contain gluten.

RESULT AND DISCUSSION

ARF made of wheat and barley was easily prepared. The best results were obtained when the wheat grains were steeped for 12 hours. Longer steeping times made the water slimy, and after 24 hours, the seed coat of the grains had ruptured, allowing starch to be released from the grains. Germination was best when allowed to occur for 48 hours. The ARF with the highest amylase activity was discovered to be produced after a 72-hour germination period and sun drying. However, after 48 hours of germination, mold growth was noticed, and amylase activity had only slightly increased.

In India, there aren't many communities that have access to such high-tech tools as ovens, but since there is a lot of sunshine for nine to ten months out of the year, it would be simple to spread the simple technique of ARF preparation by sun-drying. Although sun-dried ARF exhibited the highest amylase activity, its shelf life was only 10 days. Due to a reduced initial moisture content (caused by a higher processing temperature), toasted ARF had a long shelf life. Low moisture content prevents microbial growth and reproduction, extending the shelf life. The initial surface microbial load may also be reduced by a higher processing temperature (80 4 °C in the case of the toasted ARF).

The viscosity measurements were done to compare the catalytic activity of oven dried ARF, toasted ARF, and pure enzyme takadiastase since the toasted ARF was found to have a longer shelf life, which is a desired characteristic for any processed food and makes the product more readily acceptable. The results for all three agents were similar, proving that amylase activity of around 600–700 maltose units is sufficient to effectively reduce viscosity. This

shows that a simple process of steeping (12 hours), germination (48 hours), and toasting in a shallow iron pan at a low temperature (80 °C) can produce an ARF with good shelf life and catalytic activity. Tara Gopaldas and others, Jaggery and fat were added, and both were advantageous. They did this by first reducing the dietary bulk and then considerably upping the energy content, allowing a youngster to take more calories per unit volume of food. As a result, less frequent feedings would be required to satisfy the child's energy needs. A 20% porridge with 10 g% fat and 100 g% jaggery was used in intake experiments on infants and toddlers, both with and without ARF, to test this theory. The kids who consumed the experimental gruel consumed two to five times as many calories per sitting as the kids who consumed the control gruel. For older children (10 months or older), it was discovered during the feeding experiments that the mothers preferred thicker porridges (of spoonable consistency). It would be best to utilize the 25% slurry with ARF because it has a higher energy density and a consistency that is acceptable for child feeding. While 490 ml of a 10% porridge, 325 ml of a 15% porridge, or 245 ml of a 20% porridge would be necessary to offer the same calories, 195 ml of this porridge can meet one-third of a child's entire energy needs. The findings about how heat treatment affected viscosity decrease were both fascinating and encouraging.

It was discovered that adding 1 g% of ARF to a cooked slurry lowered the viscosity by 92%, whereas adding 6-7 g% was necessary for a comparable reduction in viscosity when it was added before to cooking. This is due to the fact that heating at 80 °C significantly lowers the concentration of the powerful amylase, which can act on starch and reduce viscosity. A significant amount of the potent amylase was preserved when the amylase was introduced to a cooked slurry chilled to 70 °C or when the fire was turned off in the porridge, leading to a higher reduction in viscosity.

Such a process has two advantages: it would be much simpler for a housewife to add a tiny amount of ARF to an already cooked and heated gruel, and much less ARF would need to be manufactured in bulk. Conclusions From this investigation, several conclusions can be drawn: Toasted ARF made from wheat is easy and reasonably priced to prepare. The roasted ARF has more than enough amylotic power to reduce thick traditional gruels, hence toasting the germinated grains is important. To prepare wheat porridges that are low in mass and high in energy by simply adding a pinch of ARF to a large cup of freshly cooked porridge. Therefore, bringing this technology from the lab to the level of the family in rural, tribal, and slum communities should be possible.

CONCLUSION

This study highlights the significant potential health effects of gruel made from wheat and barley that contains amylase-rich flour. Amylase-rich foods serve a critical function in human health, from promoting effective digestion and nutrient absorption to perhaps regulating glycemic reactions. While the enzymatic function of amylase is generally advantageous, particularly in lowering costs for the poor and children from tribal areas who do not have access to ready-to-eat supplementary feed, it is crucial to be aware of the potential risks associated with its excessive consumption, including issues with digestion, blood sugar spikes, and allergies.

To fully understand the effects of regular consumption of amylase-rich flours, we also realise the need for more in-depth study, particularly long-term studies. Future research may concentrate on determining the precise concentration of amylase that promotes the best health outcomes without triggering unfavorable side effects. Additionally, more study is required to comprehend the effects on individuals with certain medical issues as well as to lower the nation's rate of malnutrition.

Overall, gruel made from grains like wheat and barley that are high in amylase is an exciting field for research in the fields of nutrition and human health. Reaffirming the significance of comprehending the nutritional value of our foods and their broader effects on health and wellbeing, it symbolizes the junction of culture, dietary practices, and health.

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