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Pankaj Kumar
Department of Agricultural Engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Neelash Chauhan
Professor, Department of Agricultural Engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

BR Singh
Professor, Department of Agricultural Engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Vivak Kumar
Professor, Department of Agricultural Engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Suresh Chandra
Professor, Department of Agricultural Engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Bhim Singh
Professor, Department of Basic Science, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Jaivir Singh
Professor, Department of Agricultural Engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Corresponding Author:
Pankaj Kumar
Department of Agricultural Engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India

Apple Pomace powder's functional characteristics

Pankaj Kumar, Neelash Chauhan, B.R. Singh, Vivak Kumar, Suresh Chandra, Bhim Singh and Jaivir Singh

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Abstract
Apple pomace is a low-value byproduct of the apple processing industry that is frequently discarded, despite containing useful chemicals. Developing a long-term strategy for managing fruit waste has become crucial. It is anticipated that several million metric tons of apple pomace are produced globally each year. Apple pomace, which accounts for 20-30% of all processed apples, is a readily available source of bioactive compounds useful in the food sector. The functional qualities of apple pomace powder were investigated, and the results revealed a water absorption capacity of 3.56 g/g. The foam of apple pomace powder was unstable. There is much research supporting the hypoglycaemic potential of fiber in the management of diabetes. *In vitro* experiments were used in this investigation to examine the impact of apple pomace powder on α-amylase, glucose diffusion, and glucose adsorption. Dietary fiber in apple pomace powder may have a hypoglycemic impact through inhibiting glucose diffusion retardation index, amylase activity, and glucose adsorption capacity. It was found that the apple pomace powder had an α-amylase inhibition ratio of 80%.

Keywords: Apple pomace, food industry, hypoglycemic, glucose diffusion, α-amylase

Introduction

The domesticated (Malus domestica) tree, a member of the Rosaceae family, bears the apple (Malus domestica). Apples are pome (fleshy) fruits that are widely farmed worldwide. It is a valuable supplement to many diets since it is a major source of polyphenolic chemicals. Manzoor *et al.* (2021) [1]. Apples are grown on 0.313 million hectares of land in India, mostly in the northern states of Jammu & Kashmir and Himachal Pradesh. Kumar S., (2017) [2]. Apple pomace is residual pulp (54%), cores (4%), peel (34%), and seeds (7%), making up 45% of the apples produced. But as a byproduct of the juice business, pomace is also produced in large quantities and is disposed away in landfills or used as animal feed. Because fruit and vegetable pomace powders are inexpensive, readily available in large amounts, and possess a high fiber content that results in a high water-binding capacity (WBC) and relatively low enzyme-digestible organic matter, they can be utilized for fiber enrichment in food items. Serena and Kundsen, (2007) [3]. Apple pomace (AP) is one of the fruit wastes that may be a good source of phytochemicals. It also has a high carbohydrate content and a low protein, vitamin, and mineral content. Skinner *et al.*, (2018) [4]. According to estimates, only 3–10% of the antioxidant activity of the fruit used to make apple juice is retained during the production process, and the product has a low concentration of polyphenolic chemicals. Apple pomace, a diverse mixture of peel, core, seed, stem, and soft tissue, nonetheless contains the majority of polyphenolic chemicals. Apple pomace has a high moisture content (70–75%) and a high biodegradable organic content (chemical and biochemical oxygen demand). Bhushan *et al.*, (2008) [5]. Due to this, there is a significant susceptibility to microbial breakdown, which can result in unpredictable fermentation, pollution, and even hazards to public health Shalini & Gupta (2010) [6]. Drying and powdering apple pomace lowers Odor and lowers transportation and storage expenses. Additionally, it offers useful items that keep better at room temperature or components that are simpler to work with in food processors Fellows (2009) [7]. More work is required to find new opportunities and take existing applications to an industrial level Perussello *et al.*, (2017) [8]. Owing to its highly perishable nature, pre-treatment dehydration is necessary for the majority of proposed uses. Dehydration can also be used to lower bulk, increase shelf life, and save handling and shipping expenses for further processing.

It seems like a good idea to dry apple pomace for use as animal feed or to undergo additional processing like nutrition recovery. High moisture materials are dried in kilns using a method that involves mass transfer and heat, which results in the loss of different phytonutrients and powder of low quality Gullon *et al.* (2007) [9]. Using a dielectric heating method that depends on high-frequency electromagnetic oscillations brought on by molecular motion is known as microwave drying. Hang & Woodams (1995) [10]. The mechanism of energy transfer during microwave heating transfers energy directly into materials through molecular interactions with the electromagnetic field and the transformation of electric field energy into thermal energy. Because microwave drying produces heat by the instantaneous conversion of electromagnetic energy into kinetic molecular energy, it has several advantages over conventional drying Rawal & Masih (2014) [11]. Heat is thus generated deep within the item that needs to be dried. More specifically, this method has significant benefits for bulk materials with low heat conductivity when used for microwave vacuum drying Parikh *et al*., (2015) [12]. But the juice business also generates a lot of pomace as a byproduct, which is disposed of in landfills or used as animal feed S. *et al*. (2017) [13]. Because fruit and vegetable pomace powders are inexpensive, readily available in large amounts, and possess a high fibre content that results in a high water-binding capacity (WBC) and relatively low enzyme-digestible organic matter, they can be utilized for fibre enrichment in food items. Compared to wheat bran Serena and Kundsen, (2007) [14] have a higher insoluble/soluble Fiber ratio Grigelmo-Miguel and Martin-Belloso., (1999) [15].

2. Materials and Methods

2.1 Material

I purchased fresh apple pomace at the Chauhan market in Modipuram. For 24 hours the pomace was dried in a tray drier at 60±2˚C. After that, the dried pomace was ground in a Willey grinder and run through a 30 grit (500 µm) filter. After being ground, apple pomace powder is utilized for additional examination.

2.2 Water absorption capacity

The method described by Sosulski *et al*., (1976) [16] was used to assess the flour's water absorption capacity. 1 g of sample was mixed with 10 ml of distilled water, and the mixture was let to remain at room temperature (30±2 0C) for 30 minutes. The sample was then centrifuged for 30 minutes at 3000 rpm. As a percentage of bound water at a gram of flour, water absorption was measured.

2.3 Swelling capacity

To compute the swelling capacity Okaka and Potter, (1977) [17] method was applied. A 100 ml graduated cylinder was filled with the sample up to the 10 ml mark. A total of 50 milliliters of distilled water are added. The graded cylinder's top was tightly covered and mixed by turning the cylinder upside down. The penalty was flipped over again and allowed to stand for an additional eight minutes after two minutes had passed. The volume that the sample occupied was then measured.

2.4 Bulk Density (g/cc)

The apparent (bulk) density will be computed using the weight and volume of 100 g of the powder, which will be measured in a measuring cylinder (250 ml) by tapping the cylinder on a wooden board until no discernible reduction in volume is observed Jones *et al*., (2000) [18].

2.5 Foam Capacity (g/ml)

With a small change, the parameters for foam capacity (FC) and foam stability (FS) as outlined by Narayana and Narasinga 1982) [19] will be ascertained. In a graduated cylinder, 50 ml of distilled water at 30±2 °C is mixed with 1.0 g of powder sample. After mixing and shaking the mixture for five minutes, foaming will form. The formula will be used to express the foam volume 30 seconds after whipping as foam capacity:

$$Foam\ capacity\ (\%) = \frac{Volume\ of\ foam\ AW - Volume\ of\ foam\ BW}{Volume\ of\ foam\ BW} \times 100$$

2.6 Foam stability (ml)

To calculate the proportion of initial foam volume that represents foam stability, the foam volume is measured one hour after whipping.

2.7 Oil absorption capacity (ml/g)

The proportion of bound oil per gram of powder will be used to analyse oil absorption. The method for calculating the oil absorption capacity will be based on the methodology established by Sosulski *et al.*, (1976) [20]. One gram of material was mixed with ten millilitres of soybean oil (Sp. Gravity 0.9092), allowed to stand at room temperature for thirty minutes (30 °C), and then centrifuged for thirty minutes at 300 rpm, or 2000 x g. The water absorption will be analysed using the percentage of bound water absorbed per gram of powder.

2.8 Glucose absorption capacity of apple pomace powder

Glucose absorption capacity of apple pomace powder the glucose adsorption in apple pomace powder was determined using the procedure outlined in (Kwok, Li, and Fu 2001) [21]. in which 100 mL of glucose solution (10–200 mmol L–1) was combined with 1 g of sample and left for 6 hours. For a period of 15 minutes, the entire mixture was centrifuged at 3500 g. To calculate the fibres glucose adsorption capacity (Millimoles per gram), the decant solution's final glucose content was ascertained.

2.9 α-amylase activity inhibition ration (α-AAIR)

1 gram of apple pomace was mixed with twenty-five millilitres of soluble starch (4 g/100 ml, pH 6.5) and 0.1 g of α-amylase. The mixture was dialyzed against distilled water at 37 ˚C in a shaking water bath Zheng and Li., (2018) [22]. The dialysate's glucose content was determined sixty minutes later. α-AAIR was calculated using the following equation following an empty control test:

3. Statistical analysis

Microsoft Excel 7 was used to measure the mean and standard deviation of each experiment, which was carried out in triplicate.

4. Result and Discussion

The data in Table 1 demonstrate the apple pomace powder's (WAC) 3.56 g/g water absorption capacity, swelling capacity (SP) of 1274.20%, bulk density (BD) of 0.52, and capacities for foam, foam stability, oil absorption, and glucose absorption of 2.15, Zero (NS), 2.18, and 0.31 percent, respectively. Similar outcomes were noted by

Younis and Ahmad (2015) [23]. Because there were very little foam development in the powdered apple pomace, there was zero foam stability. Grover *et al*., (2003) [24] discovered that the foam capacity, foam stability, emulsion activity, and emulsion stability of the apple pomace powder were 7.0%, 0%, 39.6%, and 38.4%. The α-amylase inhibition ratio in apple pomace powder was found to be 80% (Table 1). It suggests that the most efficient amylase activity inhibitor was apple pomace powder. The inhibition of α-amylase activity may occur from several sources, including the enzymatic and starch being encapsulated by fibers, the enzyme directly attaching to Fibers and lowering amylase activity, the enzyme being less accessible to starch, and the presence of inhibitors on Fibers. Apple pomace powder has the potential to delay the release of glucose from starch, slow down the rate of glucose absorption, and ultimately regulate postprandial blood glucose levels due to its ability to reduce α-amylase activity levels Lopez and others (1996) [25]. The current investigation found that the GDRI peaked at 30 minutes (69.23%) and declined when the dialysis duration was extended. Ahmed *et al.* (2011) [26] 26 discovered that the GDRI trends in psyllium husk, acarbose, oats, and wheat bran were similar. Apple pomace powder was reported to have a considerable inhibitory effect on the flow of glucose across the dialysis membrane and into an external solution when compared to a control. The reason could be the physical barrier that glucose molecules face from Fiber particles and the way that glucose becomes trapped inside the Fiber network (Ahmed *et al*., 2011) [27]. According to the results of the current study, the GDRI peaked at 30 minutes (69.23%) and decreased as the dialysis duration increased. discovered that the GDRI trends in psyllium husk, acarbose, wheat bran, and oats were similar. Apple pomace powder was reported to have a considerable inhibitory effect on the flow of glucose across the dialysis membrane and into an external solution when compared to a control. The reason could be the physical barrier that glucose molecules face from fiber particles and the way that glucose becomes trapped inside the fiber network (Ahmed *et al*., 2016) [28].

Table 1: Functional properties of apple pomace powder

Functional Properties Treatments	(Mean ±SE)
Water absorption capacity (WHC) (g/g)	3.56±0.01
Swelling capacity (SP) (%)	1274.20±0.01
Bulk Density (BD) (g/cc)	0.52±0.01
Foam Capacity (FC) (%)	2.15±0.57
Foam stability (FS) (%)	NS
Oil absorption capacity (ml/g)	2.18±0.12
Glucose absorption capacity (mmol L−1)	0.31±0.13
α- amylase inhibition ration (α-AAIR)	75±0.02

5. Conclusion

This study led to the conclusion that apple pomace powder had a wide range of adaptable functional qualities, including the ability to hold water, absorb fat, swell, produce foam, stabilize it, and reduce the diffusion of glucose. This study shown that apple peels, or apple pomace powder, may efficiently absorb glucose. They also slow down the diffusion of glucose and limit the activity of α-amylase, which lowers postprandial hyperglycemia. The apple pomace powder was shown to have an α-amylase inhibition ratio of 80%. The GDRI peaked at 30 minutes (69.23%), and then it sharply declined. It was intriguing to observe that as glucose concentration rose, so did the amount of glucose that apple pomace powder was able to adsorb. Each of these processes contributes to lowering the rate of glucose adsorption, which lowers each of these processes contributes to a decrease in the postprandial circulating glucose levels by slowing down the rate of glucose adsorption. Nevertheless, further *in vivo* research is required to evaluate these findings.

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