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المجلة العراقية لبحوث السوق وحماية المستهلك

THE USE OF FOOD PROCESSING BY-PRODUCTS TO IMPROVE THE QUALITY CHARACTERISTICS AND NUTRITIONAL VALUE OF BAKED PRODUCTS

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ABSTRACT

About 50% of the secondary plant waste generated during the industrial production of fruits and vegetables is wasted, which negatively affects the environment and costs a lot of money. The secondary plant waste is a rich source of nutrients that support human health and protect it from many diseases (obesity and heart disease). It is also a source of dietary fiber and phenols, which are antioxidants that can be separated from wheat bran, corn bran, rice, fruit and vegetable seeds. which were introduced in the manufacture of baked products. Many studies of baked products fortified with vegetable by-products showed an improvement in the quality characteristics in addition to an increase in their nutritional value. Therefore, the aim of this article was to highlight the importance of exploiting plant residues and using them in baked products as a sustainable way to increase their nutritional value and obtain cheap products.

Keywords: Baked products, Dietary fiber, By-products, Fruits, Vegetables.

استخدام النواتج الثانوية لمخلفات التصنيع الغذائي في تحسين الصفات النوعية والقيمة الغذائية للمخبوزات

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الخلاصة

يتم إهدار حوالي 50٪ من المخلفات النباتية الثانوية الناتجة أثناء الإنتاج الصناعي للفواكه والخضروات، مما يؤثر سلبًا على البيئة ويكلف اموالا طائلة، اذ تعد المخلفات النباتية الثانوية مصدرًا غنيًا للمغذيات التي تدعم صحة الانسان لتقيها من العديد من الامراض (السمنة وامراض القلب)، كما انها مصدرا للألياف الغذائية والفينولات وهي من المواد المضادة للأكسدة التي يمكن فصلها من نخالة الحنطة والذرة والرز وبذور الفواكه والخضروات والتي تم إدخالها في صناعة المنتجات المخبوزة، لقد اظهرت العديد من الدراسات للمنتجات المخبوزة المدعمة بالمخلفات النباتية الثانوية تحسنا في الصفات النوعية اضافة الى ارتفاع قيمتها الغذائية، لذلك كان الهدف من هذه المقالة تسليط الضوء على اهمية استغلال المخلفات النباتية واستعمالها في المنتجات المخبوزة كوسيلة مستدامة لتعزيز قميتها الغذائية والحصول على منتجات رخيصة.

الكلمات المفتاحية: المخبوزات، الالياف الغذائية، المخلفات، الفواكه، الخضروات.

INTRODUCTION

Wheat bran, pineapple pomace, grape pomace, stalk and leaves from broccoli, oil made from flaxseed, and unpulled pumpkin seed, yellow linseed, sunflower seed, and walnut are just a few examples of the by-products produced during processing of plant-based food. These by-products are not very valuable commercially, however, the amount of by-products of plant-based foods produced by the food manufacturing justifies having to explore their possible application in novel foods(**Amoah *et al.*,2020).**

About 50% of the by-product waste produced by industrial fruit and vegetable production is made up of pomace, peels, cores, unripe, or injured produce **(Padayachee *et al.*,**

2017) by product substances are extremely vulnerable to microbial and enzymatic degradation. Dietary fiber is linked to plant foods like cereals, vegetables, fruits, and nuts, though the quantity and make up of dietary fiber might differ from food to food compared to starchy meals, which have 10 g of dietary fiber per 100 g of dry weight, foods rich in non-starch polysaccharides have high levels of dietary fiber, ranging from 20 to 35 g /100 g **(Sahni &Shere,2018)**. According to **(Selvendran & Robertson, 1994),** Due to the hazardous and carcinogenic properties of the latter, the use of natural antioxidants in place of synthetic butylated hydroxy anisole (BHA) and butylated hydroxytoluene (BHT) may be of interest. Numerous epidemiological studies have suggested that consuming natural antioxidant-rich meals, like as fresh fruit and vegetables can help protect against a number of diseases. Vitamins, flavonoids, anthocyanins, and other phenolic chemicals, among others, have all been linked to this form of protection **(Afsharnezhad *et al.* 2017).**

Fruits and vegetables byproduct are nevertheless abundant in nutrients and non-nutritional substances that support intestinal health, weight control, decreasing blood cholesterol, and better glycemic and insulin response regulation. Because fruits and vegetables byproduct components aid in the proper digestion of starchy, high-glycemic-index carbs **(Aziah *et al.*, 2011).**

Aims of study

The investigation's purpose is to ascertain to provide readers a detailed grasp of how the origin and physical characteristics of plant-waste byproducts affect the physical and nutritional value of commonly consumed baked products such cookies, breads and cakes.

First: Phenolic substances

Additionally, fruits and vegetables are distinguished by their high polyphenol content depending on their source, 274 mg/100 g in sweet cherry, for instance. In reality a lot of the fruits and vegetables that serve as the basis for these by-products are among the top 100 dietary sources of polyphenols, according to a list **(Perez-Jimenez *et al.*, 2010).** It is redox attributes may help to explain the intense interest in some polyphenols their function in preventing a number of serious chronic disorders cardiovascular disorders, for example, are linked to oxidative stress osteoporosis, type 2 diabetes, cancer, or neurological conditions (**Gomez & Martinez, 2018).**

Second: Processing of fruit and production of by-products

A critical challenge for global food safety is the management of food waste, one of the major sources of food waste is the fruit processing industry. The Europe Commission suggested new aims in this case on reducing fruit waste in order to accelerate Europe's transition to a CE **(da Silva & Jorge, 2017**). Many natural consumer goods are produced by the fruit processing businesses, including juice, jams, salads, and snacks. However, these processes result in large quantities of fruit byproducts such peel, seeds, pomace, bagasse, and so forth. These organic matrices actually, however, still include significant amounts of bioactive compounds (BCs), primarily proteins, phenolic compounds, pectin, and antioxidants which have advantages for human health. Additionally, some the by-products abundant. Fruit juice production generates a lot of byproducts, and their disposal could be problematic. Typically, these items are utilized in animal feeding. However, because of their high dietary fiber content, they might be used to create new all-natural food ingredients. The need for a distinctive fiber element will persist. It seems obvious that a novel ingredient, especially one

that might be connected to the prospect of meeting nutritional requirements through customary eating patterns, would be highly received given the established market for dietary fiber **(Campos *et al*., 2020)**. Fruit peels are typically discarded as environmental garbage, yet the presence of many phytochemicals makes them an essential alternative source of natural antioxidants and ant nutrients, just like any other plant Therefore, care should be taken to extract these chemicals correctly and to determine whether they are suitable for use as repetitive. The overall value of the agricultural industrial waste will rise as a result. Food, forest, or agricultural businesses produce wastes (**Agbaje *et al*.,2020).**

Numerous fruit wastes, such as apple and banana, are reported to be high in fiber, potassium, biotin, copper, manganese, and vitamin B6. Fruit wastes could be recycled as a useful way to lessen environmental contamination caused by their deterioration. Their secondary metabolite content can prevent high blood pressure and shield against atherosclerosis if the process is carried out in an appropriately regulated manner. Many fruits have concentrated levels of tryptophan in their skins. This crucial amino acid can be transformed into serotonin, which helps treat and prevent depression. A significant amount of iron can be found in some fruit wastes, which helps treat anemia, stop the loss of calcium, and build bones. Banana wastes are a natural antacid that helps relieve heartburn, acid reflux, and replace electrolytes lost due to diarrheal dehydration. A billion pounds of peels are currently thrown into landfills every year, wasting their potential benefits. However, given that the average person consumes 500 grams of mixed fruits per day and that about 40% of the weight of fruit is waste, it makes sense to explore some of their potential uses for the environment and way of life (**Afsharnezhad *et al*. 2017**).

A- Apple

Apples (*Malus domestica Borkh*.) are a popular and well-liked fruit thanks to their delectable flavor and aroma as well as their numerous, well-documented health advantages **(Othman *et al*., 2020).**

Estimates, about 366 million tons of apples and 3-4.2 million tons of byproducts manufactured from apple pomace are produced per year. The apple pomace includes the peel, seeds, stem, cores, and certain edible parts (remnant), which are frequently produced during the processing of apples **(Campos *et al*., 2020)**.

The abundance of apple by-products leads to a variety of concerns with disposal and transportation. However, these substances are excellent polyphenol sources which are primarily found in peel Catechin, quercetin, hydroxycinnamic acids, and epicatechins are the most widely recognized BCs However, apple byproducts with high pectin content have been useful for a variety of industrial uses, including as a precursor to bioethanol, a food thickener, and other biofuels, gelling and stabilizing agent **(John *et al*.,2017)**.

B- By-products from tropical fruits

The two tropical fruits that are most common are the banana and mango. The banana is a significant crop grown mostly in Asia, South America, and Africa in tropical and subtropical climates. In 2017, the production of by-products, primarily peel, was predicted to be 101 million tons, approximately 35–40% of the raw fruit's weight (**Campos *et al*., 2020**). The banana (*Musa L. sp*.) is a tropical fruit that was produced in roughly 113 million tons in 2017 that is incredibly popular and widely consumed. The peel, which makes up around 35% of the total weight of the fruit but is not edible, is thrown away as trash. Peel has long been used as a treatment for managing diabetes and anemia as well as common conditions such inflammation,

burns, and cough. The isolation of nutraceuticals with potential for health benefits from banana peel is thought to be possible. A banana's peel is a good source of dietary fiber, potassium, polyphenolic compounds, and essential amino acids. (**Othman *et al*.,2020).**

C- Mango

A popular tropical fruit crop is the mango (*Mangifera indica* L.) was predicted to yield around 50.6 million tons in 2017. The majority of mangoes are eaten fresh or cooked, but they can also be mashed, dehydrated, canned, frozen, turned into jam, or frozen (**Othman *et al*., 2020**). Mango by-products, which are made from the fruit's pulp and peel, a substantial amount of fiber, mostly insoluble fiber (**Ajila &Rao, 2013**) contains bioactive substances as carotene and flavonoids. The variety, degree of ripening, and earlier therapies, such as irradiation, drying, or blanching, all affect the make-up of mango byproducts. Mango phenolics' ability to it has also been shown to inhibit digestive enzymes (a-amylases and mucosal a-glucosidases). Mango byproducts may therefore be useful for lowering the rate at which baked products' glycemic carbs are digested and, consequently, glycemic reaction (**Gomez & Martinez, 2018**).

D- pineapple

Tropical fruit pineapple has enticing sensory and nutritional qualities (vitamins, antioxidants, and fibers), which are complimented by a natural catalyst called bromelain (**Coelho *et al*., 2013)**. A good source of ascorbic acid is fruit (vitamin C), carotene (vitamin A), and is too reasonably rich in vitamins B and B12 dietary fiber, calcium, iron, fat, protein, and carbohydrates (**Devi *et al*., 2015).** When pineapples are canned or eaten, the crown, outer peel, and center core are discarded as pineapple waste, which makes up about 50% of the weight of the entire fruit and amounts to around ten tons of fresh or one ton of dried pineapple waste hectare. It is advised to utilize pineapple wastes as excellent sources of organic raw materials because they might be turned into usable products. It has a lot of crude fiber and sugars that are good for microbial growth. Furthermore, fermentation is required to increase the nutritional content of agro-industrial wastes (**Rashad *et al.*, 2016**). According to (**Martìnez *et al*., 2012)** the fiber content of pineapple byproducts (peel and heart) is about 76%, with 99.2% of it being the insoluble fraction and 0.8% the soluble portion. The pomace of pineapples includes valuable they are sources of dietary fiber and may be utilized as a culinary component to enhance the nutritional value of foods.

E- By-products of citrus fruit

Over 88 million tons of citrus fruit, including lime, lemon, mandarin, and orange, were produced globally in 2017. Because they contain a significant amount of citric acid, citrus fruits are categorized as having an acidic flavor., a potent organic antioxidant. Most often, such fruits are bought at the marketplace and consumed as fresh produce or as manufactured goods used as flavors, juices, or marmalades However, this industrialization generates a sizable amount of citrus byproducts, most frequently peel **(Campos *et al*., 2020).**

Rag, seeds, and peel (the membranes between the citrus fruits) are all waste byproducts produced in vast quantities by the processing industry sectors and pulp, which account for between 50 and 60 percent of the fruit's total waste after juicing. After juice extraction, citrus peel is the predominant waste portion, making up over 50% of the fruit mass. It is important to clarify Citrus peel is regarded as a valuable functional food and is a waste product of citrus industries. Citrus peels may therefore boost health in addition to the typical nutrients they provide and guard against diet-related diseases. One of the most major applications for orange

peel waste is pectin manufacture. Citrus peels account for over 85% of the pectin produced (39% from limes, 13% from oranges, and 56% from lemons) **(Zaker *et al*., 2017).** Citrus pectin, Citrus peel pectin, regarded for its practical properties and widely used as a food thickening, stabilizer, and gelling agent. Additionally, it has several uses in the pharmaceutical and cosmetic industries (**Othman *et al*., 2020).**

F-grapes

Since about 67% of all grapes are used to make alcoholic beverages like wine, important cash crop that has a beneficial economic impact globally is grapes. (**Deng *et al*., 2011).** This by-product is primarily made up of seeds and skin, both of which have been shown to be rich sources of BCs like phenolic acids, flavonoids, anthocyanins, and proanthocyanin's According to certain publications, these BCs are quite interesting due to their biological and pharmacological characteristics, which include cardioprotective, antibacterial, and antioxidant activity (**Compase *et al*., 2020).**

G- Melon

Juicy, flavorful, and delectable melon fruit is widely recognized for its nutritional and therapeutic benefits inherently It can be a good source of minerals, dietary fiber, and other nutrients and is low in fat and sodium, polyphenols and carotenoids (**Vishwakarma *et al*., 2017**). Estimated annual global production of melons is 49 million tons industrial processing once more produces large amounts of peel and seed uses that are not featured or valuable byproducts. About 25% of melon are its peel and seeds and 7% of the fresh total weight, respectively, meaning that byproducts make up more than 30% of the total weight., resulting in hefty financial losses, these by-products also stand out due to the high BC concentrations and have aroused interest from scientists because of their potential (**Mallek-Ayadi *et al*., 2018**). As well as that, Cucumis , a serine protease found in melon fruit, is useful in the food industry. This information has led to an increase in studies on melon by-products., which has increased their commercial importance while also raising worldwide challenges **(Compase *et al*., 2020).**

Third: Unknown vegetable wastes

In addition to the vegetable wastes that have been thoroughly researched for recovery of bioactive substances, in addition, a large number of leftover vegetables that have not been thoroughly studied. among the wastes are some of those. produced from conventional vegetables with a limited shelf life, such as mushrooms, spinach, garlic, eggplant, and other leafy green vegetables, as well as from cabbage and other members of the Brassicaceae family. Garlic and onion skin and peel, which produce a significant quantity of trash, is one of the most recently examined materials being evaluated. According to reports, the skin component is abundant Alkyl cysteine sulfoxides, phenolics, flavonoids, flavanols, quercetin, aglycone, fructus, and dietary fiber combined, and it also has anti-inflammatory, antibacterial, antispasmodic, and anti-diabetic properties **(Othman *et al*., 2020).**

A-Tomato

The tomato is a crop that originated in South America and is regarded as valuable. One of the most significant fruits grown globally, fresh tomatoes have an annual global production close to 242 million tons, according to (**Compase *et al*., 2020)**. About 3-7% of the weight of a tomato is produced during the processing of tomatoes, which poses major environmental issues for the sector in question due to the organic material's disposal. The majority of the by-

products, or tomato pomace, consists of Various ratios of seeds, peels, and a tiny quantity of pulp some by-products in small amounts are utilized as soil fertilizers or as animal feed **(Migalatiev, 2017).** Tomato seeds were found to contain significant concentrations of essential amino acids, indicating that they contain high-quality proteins with a high lysine content (3.4-5.9%). A little more than 13% more lysine can be found in tomato seeds than in soy protein. Consequently, the tomato various low-lysine food products that are lacking in this amino acid may benefit from seed fortification. One of these products is bakery goods, which use wheat flour as a basis ingredient because it contains less lysine. Tomato seeds are also a better source of proteins than other unconventional sources because they have no anti-nutritional components that have been observed in other seed sources **(Mironeasa & Codina, 2019).**

Fourth: Fruits and vegetables byproduct is used in baked products.

People of all ages enjoy the great variety of products found in bakeries, such as cakes, breads, biscuits, etc. Considering the popularity and need for bakeries products also have the ability to be a vehicle for nutrient fortification and improvement. Cakes and cookies are examples of bakery goods that are low in fiber but high in starch, fat, and energy. Numerous epidemiological studies have shown that a high consumption of dietary fiber is linked to lower levels of blood pressure, LDL cholesterol, and related cardiovascular illnesses **(Allsozai &Alam, 2018**). Since most baking procedures (formulation, water, mixing, fermentation, etc.) are customized for each baked good Food technologists and scientists have primarily tried to maximize the use of fruits and vegetables byproduct by: 1. regulating the amount utilized; and 2. choosing the optimum source of fruits and vegetables byproduct. Less work has been put towards collecting systematic data, however, on the physical characteristics of fruits and vegetables byproduct and how they affect the quality of food, Due to their high glycemic index, baked foods can be used as a model for food systems that accept fruits and vegetables byproduct (**Gomez & Martinez, 2018**).The nutritional content of bread can be increased by including by-products of plant-based foods, which may decrease food waste and enhance consumer nutrient status. Despite this, the inclusion of plant-based the use of food waste as a functional component in bread affects customers' organoleptic perceptions and has an impact on the nutritional value and bioactive characteristics of the bread **(Amoah *et al*., 2020).**

Table (1): The utilization of by-product fruit and vegetables in the production of baked products

Source	By-Product fruit and vegetables	Value-Added Product	Manufacturing
Orange	Peel	Fiber	Cakes
Potato	Peel	Fiber	Biscuits
Tomato	Pomace	Fiber	Cookies
Passion	Peel	Fiber	Biscuit
Watermelon	Peel	Fiber	Cake
Citrus	Peel	Fiber	Cakes
Pomegranate	Seed	Fiber	Bread
Carrot	Pomace	Fiber	Sweet fried cookies
Balady orange, Carrot	Pomace	Fiber	Cake
Pineapple	Pomace	Fiber	Biscuits
Carrot	Pomace	Fiber	Cookies
Carrot	Pomace	Fiber	Cookies
Carrot	Pomace	Fiber	Biscuits
Pineapple, apple, Melon	Peel	Fiber	Cookies

Cookies and biscuits in particular are wonderful carriers for fiber enrichment because they have become a necessary part of our lives and are perfect for replenishment because to the product's palatability, compactness, ease, and long shelf life as well as the fact that it is commonly consumed by everyone, regardless of age (**Sahni &Shere, 2018).**

In the creation of novel meals, fruits and vegetables byproducts from melon, pineapple, and apple could serve as an alternate source of nutrients. bakery products, cookies, for example, are regarded as the greatest foods to increase nutritional value since they are adaptable and enjoy a high level of acceptance (**Toledo *et al*., 2017**).

Additionally, it has been discovered that using fruits and vegetables lessens byproducts bread staling, which has a positive effect on bread quality. This outcome could be explained by the fiber content. of fruits and vegetables by-products utilizing pure fibers, as previously reported (**Gomez &Martinez, 2018**). Fiber may improve the final bread's ability to retain water and decrease the rate at which amylopectin molecules retrograde (**Ronda *et al*., 2014**). Due to their high glycemic index, baked foods can be used as a model for food systems (**Gomez &Martinez, 2018**).

CONCLUSION

High concentrations of bioactive substances, such as polyphenols can be found in a variety of food byproducts such as rice bran, wheat bran, peel, core, pomace, and seed. with improved bioavailability and bio accessibility of the bioactive components, the usage of plant-based by products in bakery products revealed favorable bioactive features in human blood. Fruit and vegetable by-products can be incorporated in bakery products not affect the quality attributes and also tend to improve the sensory attributes of the product. Being an inexpensive source of dietary fiber. Further study is required to examine the use of scientific studies to confirm the health benefits of long-term bakery products consumption enhanced with plant-based byproducts. New study fields should also look at the bioactivity of additional underutilized plant-based food by-products, their potential combination into the formulation of bakery products.

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