

<b>Review Article</b>	<b>Pak-Euro Journal of Medical and Life Sciences</b>
DOI: 10.31580/pjmls.v8i2.3250	Copyright © All rights are reserved by Corresponding Author
VoL 8 No. 2, 2025: pp. 489-500	
www.readersinsight.net/pjmls	<b>Revised: June 07, 2025</b> <b>Accepted: June 15, 2025</b>
<b>Submission: March 16, 2025</b>	<b>Published Online: June 29, 2025</b>

## BIOLOGICAL PROPERTIES AND EDIBLE COATING POTENTIAL OF *PRUNUS AMYGDALUS* AND *CITRULLUS LANATUS* KERNEL OIL FOR APPLE PRESERVATION: A REVIEW

Fahad Rasheed<sup>1</sup>, Zeenat Hamid<sup>1</sup>, Mehnaz Hashim<sup>1</sup>

<sup>1</sup>Department of Microbiology, University of Balochistan, Quetta, Pakistan

**\*Corresponding Author:** Fahad Rasheed. E. mail: [fahad\\_khetran@yahoo.com](mailto:fahad_khetran@yahoo.com)



### Abstract

This review highlights the potential benefits of *Prunus amygdalus* (almond) and *Citrullus lanatus* (watermelon) kernel oils. *Prunus amygdalus*, a member of the genus *Prunus*, and *Citrullus lanatus*, from the Cucurbitaceae family, are cultivated in tropical and subtropical regions. The seeds of these fruits are rich in both macro- and micronutrients. Literature reports indicate that Cucurbitaceae seeds contain approximately 50% fat and 35% protein, with watermelon seeds exhibiting particularly high lipid content. Almond kernels are also highly nutritious, and the shells and hulls are traditionally used as cattle feed or fuel. Almonds are an excellent source of fiber, protein, and essential minerals, making them valuable in various industries, including food, cosmetics, and medicine.

Apples, ranked as the fourth most nutritious horticultural fruit globally, are prone to rapid spoilage post-harvest. The application of edible natural antibacterial coatings has emerged as an innovative preservation strategy. These gum-based coatings function by limiting respiration and oxidation through the regulation of gas exchange, thereby slowing down ripening and decomposition. Incorporating such coatings enhances the shelf life and visual appeal of fruits, offering a promising, eco-friendly approach to food preservation.

**Keywords:** Horticulture, Hull, Macronutrient, Micronutrient, Minerals, Preservation

## INTRODUCTION

*Prunus amygdalus* or *Prunus dulcis* (almond) is a member of the genus *Prunus* and the subfamilies Prunoideae and Amygdaloideae within the larger family Rosaceae (1, 2). Growing to a height of 4–10 meters, the almond is a small deciduous tree with a trunk diameter of around 30 centimeters. The youngest, most tender twigs start off green but turn purple when exposed to light. The length of the leaf ranges from around 3 to 5 inches, and the tree takes between five and six years from the time it was planted until it reaches maturity in the fall (1, 3). Almonds and other nuts are germ-resistant due to their high fat, protein, and low water content. Molds may develop under storage settings (2).



**Fig. 1.** A botanical description of (a) *Prunus amygdalus* (b) *Citrullus lanatus* plant

*Citrullus lanatus*, a member of the Cucurbitaceae family, originated in Africa at least 4000 years ago and is now cultivated on every continent, originating in tropical and subtropical regions, and is commonly

known in Pakistan as tarbooz (Urdu) (6). As a member of the Cucurbitaceae family, watermelon is related to cantaloupe, squash, and pumpkin, as well as other vine-growing plants. Watermelons are warm season, elongated annual fruits with tendrils at the node and a shallow root system; they typically mature in August. Their leaves are large and lobed. Big, golden flowers appear at the branches' ends and include several smooth, compressed, black or yellow-white seeds with thickened margins. The most often discarded oil seed is from a watermelon. The watermelon fruit included several smooth, compressed, black or yellow-white seeds with thickened margins (7).

### WORLDWIDE PRODUCTION OF *PRUNUS AMYGDALUS* AND *CITRULLUS LANATUS*

Global almond production was 41,400,433 tons in 2020, according to the Food and Agriculture Organization. (8). Pakistan ranked 18th in worldwide production of almonds, and the 2019 almond harvest was 19,994 tons. Most of Pakistan's almonds come from the region of Baluchistan, Loralai district, which has a total area of 4,783 acres and produces 12,577 metric tons annually (9).

The annual global watermelon production is around 110 million tons. In 2020, China produced 60246888 metric tons of watermelon, while Turkey is 3,870,515 metric tons (10). The production of watermelons in all of the world's major areas in the years 2019, 2020, and 2021 was examined side-by-side as shown in figure 3, and the results revealed that during all three of those years, production remained consistent, with Asia emerging as the world's leading watermelon producer (11). Pakistan is responsible for 0.5% of global watermelon production and ranks 20<sup>th</sup>, the highest cultivation takes place in the province of Sindh, Punjab, Balochistan and Khyber Pakhtoon Khwa respectively. In the Baluchistan area, farmers from Noshki and Panjgur cultivate watermelons (12).

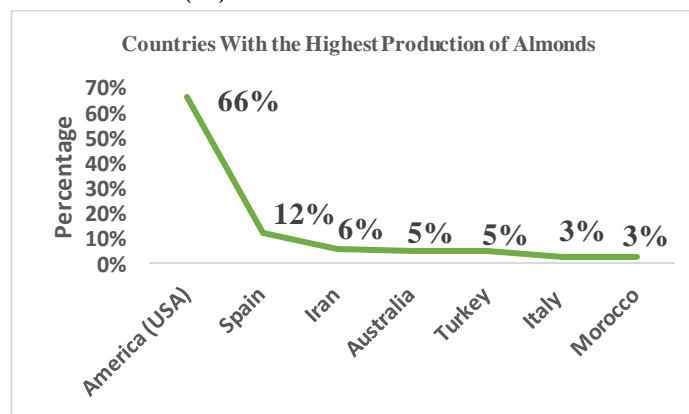


Fig. 2. Countries with the highest production of almonds (Data extracted from Mesías et al., 2023)

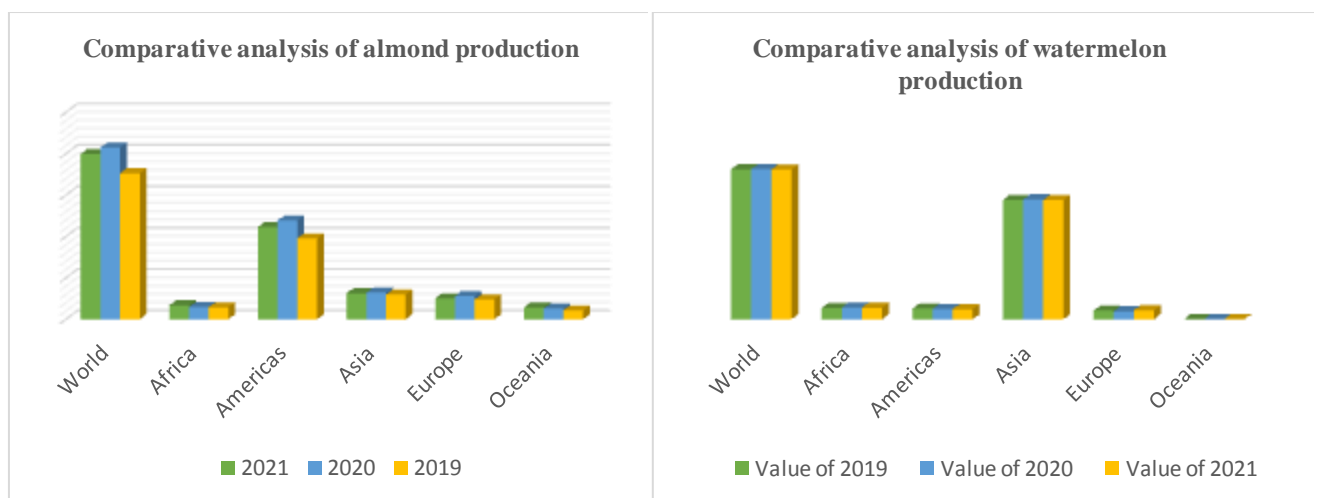


Fig. 3. Comparative analysis of (a) *Prunus amygdalus* and (b) *Citrullus lanatus* production across different regions in the years 2019, 2020, and 2021 (adapted from FAOSTAT 2021)

## BIOACTIVE COMPOUNDS OF *PRUNUS AMYGDALUS* AND *CITRULLUS LANATUS*

Almonds contain a significant amount of both macronutrients and micronutrients, making them a very valuable food source. In addition to crude oil, oleic and linoleic acids, -sitosterol, and -tocopherol, almonds are packed with a wide range of essential nutrients. In addition to being a rich source of monounsaturated and polyunsaturated fatty acids, phytochemicals, bioactive compounds, minerals (potassium, magnesium, calcium, and phosphorus), flavonoids, and phytosterols as shown in figure 5, almonds also contribute to the body's ability to fight against different diseases (13, 14). Seeds of *Prunus amygdalus* are high in many different vitamins and minerals, according to an FDA survey as shown in table 1 (15). The fatty acid composition of *Prunus amygdalus* showed that the principal fatty acid examined in all materials was oleic (60.72%), as shown in Table 2, and magnesium and phosphorus were found to be the most common minerals in the sample with high concentrations.

Due to their adaptability, almond seeds and oil are used in many different recipes. Almonds, which have been shown to have cardioprotective effects, are often recognized as a nutritious food choice (4). Almonds have great antioxidants. It protects against oxidative stress, which causes cancer, aging, and inflammation. The brown coating on almonds is a rich source of antioxidants (16). Among the best food sources of vitamin E and manganese, almonds have been recognized by the US Food and Drug Administration (17). Almonds' antioxidant and nutritional composition, which contains several minerals and phytochemicals, can benefit health. Almond genotypes like Patasa & Talwar (Pakistani) and Abdul Wahidi & Katha (Afghani) have differing nutritional and antioxidant profiles. Talwar and Abdul Wahidi had better nutrition than Patasa and Katha. Almonds are abundant in protein and fiber. Almonds are elegant, tasty, and excellent radical scavengers (18). There has been talk about the potential anticancer effects of Rosaceae extracts. It has a lengthy history of use in traditional medicine, dating back over 3,000 years. Many of Japan's traditional medical texts, like the 1817 Shokokukodenhiho and the 7th-century Ishinho, discuss the usefulness of fruit flesh in treatment (AD 984) (19). Almonds contain anti-stress, antioxidant, immunological, cholesterol-lowering, and laxative properties. It boosts mental energy, physical strength, and lifespan. Polyphenols, a common vitamin, prevent cancer and cardiovascular disease. The health benefits of polyphenols vary with the quantity taken and their bioavailability. Various phenolic compounds derived from almonds and their metabolites are addressed, along with their antioxidant properties and their use as dietary antioxidants. Lowering cholesterol and blood sugar levels are further benefits. Helps curb cravings, which is very helpful for dieters. Some people are allergic to almonds, and it might cause them to throw up, feel queasy, have stomach pain, and have trouble swallowing (1, 20).

The sweetness and sugar content are major factors in the overall quality of many kinds of watermelon. Because of its low-calorie count and high nutrient and water content, it is widely consumed as shown in table 1. The fatty acid composition of *C. lanatus* showed that the principal fatty acid examined in all materials as shown in table 2 was Linoleic (56.9%) and Iron, with a concentration of 144.70mg, is by far the most prevalent mineral in the sample. Watermelon can be used as a fresh ingredient in a variety of salads, desserts, snacks, and even decorations. Beverages may be made from the juice as well. There are high levels of lycopene and carotenoids in the fruit, according to reports. In addition, it's rich in the amino acid citrulline, which plays a role in the production of arginine (21). The carotenoid lycopene in watermelon is excellent for human health. Lycopene's cancer-fighting properties are expanding rapidly. Delicious watermelon quenches your thirst and reduces inflammation, which may aid in the treatment of ailments including asthma, atherosclerosis, diabetes mellitus, cancer, high blood pressure, hypertension, and rheumatoid arthritis (22). There is a high concentration of lipids in watermelon seeds. Furthermore, watermelon seeds are an excellent source of fat, protein, B vitamins, and minerals (particularly iron, zinc, manganese, and copper), among many other nutrients (23-25). Fruits and vegetables have been shown to reduce blood cholesterol and protect against inflammatory bowel disease because to the high fiber content they contain (7, 26).

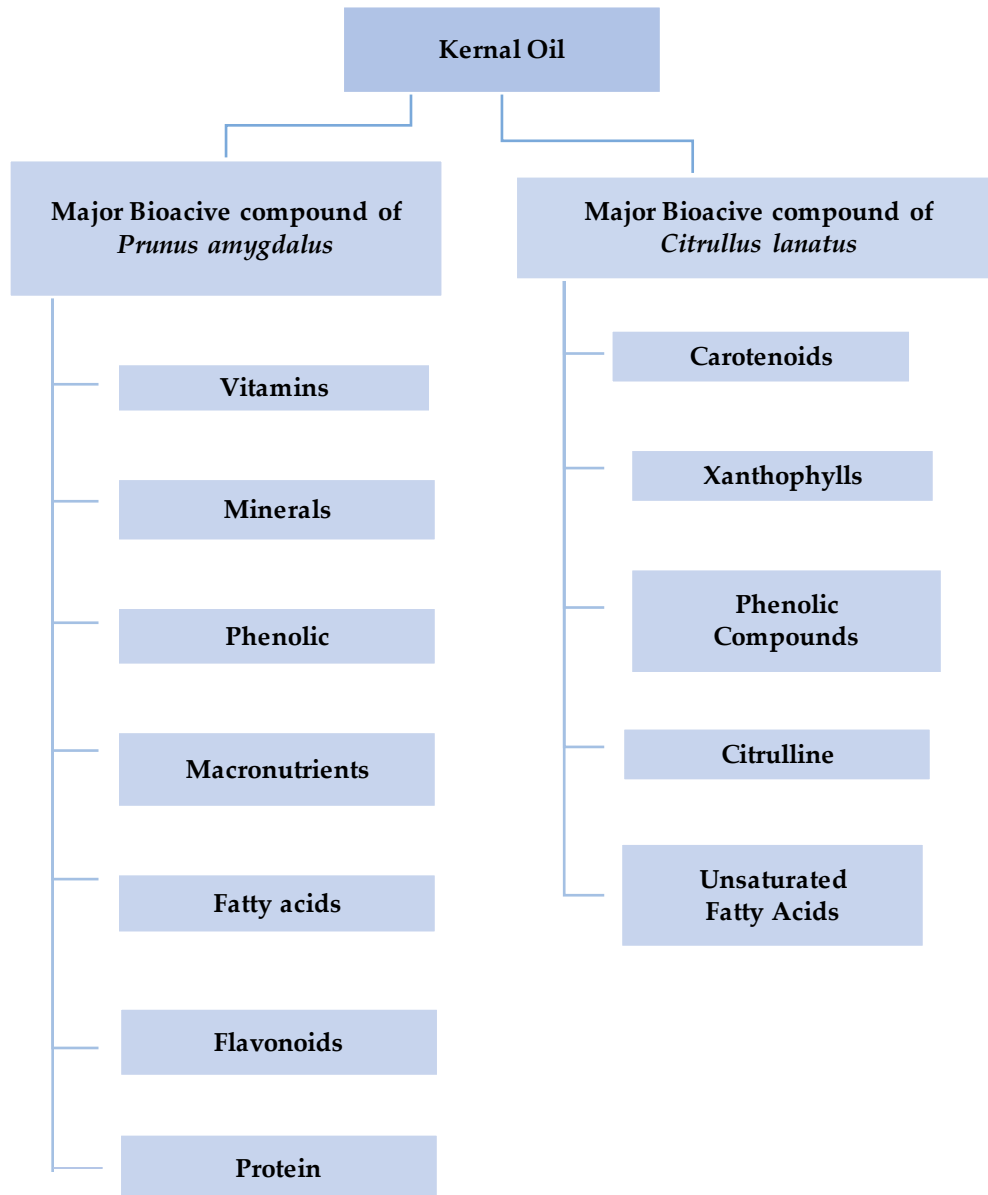


Fig. 4. Bioactive compounds of *Prunus amygdalus* and *Citrullus lanatus*

Table I. Macronutrients, Vitamins and minerals found in *Prunus amygdalus* and *Citrullus lanatus* kernal oil

Macro nutrients	Quantity (100g) ( <i>P. amygdalus</i> )	Quantity ( <i>C. lanatus</i> )	Vitamins	Quantity ( <i>P. amygdalus</i> )	Quantity ( <i>C. lanatus</i> )	Minerals	Quantity ( <i>P. amygdalus</i> )	Quantity ( <i>C. lanatus</i> ) mg/kg
Water	4.70 g	91.5 g	Vitamin A (Retinol)	0% 0 µg	596 IU	Calcium	26%, 264 mg	7 mg
Energy	kcal 575	32 kcal	Vitamin B1 (Thiamine)	18%, 0.211 mg	0.08 mg	Copper	50%, 0.99 mg	13.27
Protein	g 21.22	0.6 g	Vitamin B2 (Riboflavin)	85%, 1.014 mg	0.02 mg	Iron	29%, 3.72 mg	144.70mg
Total fat	g 49.42	0.4 g	Vitamin B3 (Niacin)	23%, 3.385 mg	0.2 mg	Magnesium	75%, 268 mg	10 mg
Total sugars	g 3.89	7.2 g	Vitamin B5 (Pantothenic Acid)	9%, 0.469 mg	0.22 mg	Manganese	2.285 mg	0.03 mg
Dietary fiber	12.20 g	0.4 g	Vitamin B6 (Pyridoxine)	11%, 0.143 mg	0.045 mg	Phosphorus	69%, 484 mg	8396.93
			Vitamin C (Ascorbic Acid)	0% 0 mg	9.6 mg	Potassium	15%, 705 mg	112 mg
			Vitamin E	171% 25.6 mg	0.05 mg	Selenium	4% 2.5 µg	2871.26
			Folate (B9)	13% 50 µg	2 mg	Sodium	0% 1 mg	1 mg
						Zinc	32% 3.08 mg	0.10 mg

\*Data were extracted and adapted from Singh et al., 2022; Richardson et al., 2009 and Khalid et al., 2021

**Table II.** Fatty acid composition of *Prunus amygdalus* and *Citrullus lanatus* seed oils (%)

Fatty Acid	Composition % of <i>Citrullus lanatus</i>	Composition % of <i>Prunus amygdalus</i>
Myristic acid	0.7	0.04
Palmitic acid	13.5	6.52
Stearic	13.7	1.45
Oleic	14.6	60.72
Linoleic	56.9	29.05
Saturated fatty acid	28.1	11
Monosaturated fatty acid	14.5	59
Polyunsaturated fatty acid	57.4	30

\*Data on *Prunus amygdalus* were extracted from Allaith et al., 2019, while data on *Citrullus lanatus* were derived from Oluba et al., 2008

## ANTIBACTERIAL ACTIVITY OF *PRUNUS AMYGDALUS* AND *CITRULLUS LANATUS*

Usually the seed oils have strong antifungal, antibacterial and antioxidant activities which are proved by previous studies. Watermelon seed oil has antibacterial properties, particularly against *Staphylococcus* species and *P. aeruginosa* (33). Watermelon showed susceptibility to *Klebsiella pneumonia* and *Escherichia coli* (34). Watermelon seeds have antibacterial properties against gram-negative bacteria (*Y. enterocolitica*, *P. multocida*, *P. aeruginosa*, *X. campestris*, *K. pneumoniae*, *E. coli*, and *S. marcescens*) as well as gram-positive bacteria (*B. subtilis* and *S. aureus*). Moreover, investigated that almond oil also shows significant antibacterial activity against soil born pathogen (35). Alkaloids, glycoside, tannins, and phenols are among the phytochemicals responsible for the notable pharmacological activity of watermelon seed oil and almond oil, reported that *S. aureus* and *E. coli* were inhibited largely by almond oil. (36) Additionally, watermelon seed oil expressed significant antibacterial potential against *Staphylococcus* species and *Pseudomonas aeruginosa* (36, 37). Earlier, seed oil of watermelon seed oil indicates that it has both bacteriostatic and Bactericidal abilities against the test organisms (*S aureus* and *P. aeruginosa*) (38).

## ANTIFUNGAL ACTIVITY OF *PRUNUS AMYGDALUS* AND *CITRULLUS LANATUS*

Almond oil and watermelon seed oil are effective on fungal species including *A. niger*, *M. muccedo* and *A. flavus*. A previous study indicated that *A. nigar* was very sensitive to watermelon seed (33, 37). Recent study proved that that Watermelon seed oil exhibited antifungal properties against *C. albicans* and *A. niger* (39). Several therapeutic effects of almond and watermelon oil have been reported by several authors. Research published by Ghadimi *et al.*, 2020 (40) claimed that terpenes and terpenoids present in oil possess potential antileishmanial activity (40). Both these compounds are identified in current study. Almond and watermelon contain several bioactive compounds like linoleic acid, sitosterol and oleic acid that possess antimicrobial activity.

## ANTI-INFLAMMATORY ACTIVITY OF *PRUNUS AMYGDALUS* AND *CITRULLUS LANATUS*

According to Guici *et al.*, 2023 (41) almond oil showed dose-dependent anti-inflammatory activity both in vitro and in vivo. Almond seed extract and fractions as potent inhibitors of trypsin that compete favorably with aspirin (42). It has been verified that watermelon seed has potent anti-inflammatory and antioxidant potential, which fitted well with their use in folk medicine (43). A research conducted on the anti-inflammatory properties of watermelon seed oil in a rodent model by Erhirhie *et al.*, 2013 showed efficiency (44). Oils from plants have been shown to be useful in treating wounds, epidermal tumors, skin aging, and skin barrier function. Since they have a significant anti-inflammatory effect, phenolics are very significant chemicals in antioxidant activity (45).

## BIO PRESERVATION POTENTIAL OF *PRUNUS AMYGDALUS* AND *CITRULLUS LANATUS*

Among tree nuts, almonds have the largest yield, making them a consumer favorite across the globe. Bitter almonds and sweet almonds are the two types of almonds available. Sweet almonds can be

eaten, but their poisonous counterparts cannot. When compared to its sweet counterpart, the bitter almond is noticeably shorter and wider (46). The amount of cyanogenic diglucoside amygdalin in almonds is what makes them bitter. Almonds have a constant oil content that makes up 50% of the total. Hydrogen cyanide is created when you grind up bitter almonds. The kernel, almond hull, middle shell, and brown skin or seedcoat make up an almond fruit. The kernel of the almond fruit is nutritious, and the shells and hulls of the fruit were fed to cattle and burned as fuel (13, 47). The kernel is a nutrient-rich source. As a nut, almonds provide a wealth of nutrients, including fiber, protein, and essential minerals. Raw or cooked, they're delicious (46, 48). Almond seeds and seed oils are consumed on their own or in a variety of food preparations due to their versatility. Due to their potential cardioprotective properties, almonds are regarded as a healthy snack when eaten (14).

The almond kernel produces "oleum amygdalae" fixed oil. It's water-insoluble yet soluble in ether and chloroform and it replaces olive oil. Sweet almond oil comes from dry almond kernels. Massage oil has anti-inflammatory, immunity-boosting, and anti-hepatotoxic effects. Cancer risk is lowered by almonds. Breast cancer risk is two to three times lower with a higher almond intake (49). Ancient Chinese, Greco-Persian, and ayurvedic medicine employed almond oil to cure psoriasis and eczema. In addition, scientific and anecdotal evidence suggests that almond oil might help reduce hypertrophic scarring after surgery by reviving and softening the skin. Given its emollient and sclerosant properties, almond oil has been used to lighten skin and enhance complexion (49).

Major edible oils are extracted from palm oil and peanuts, which are expensive and labor intensive; consequently, it is necessary to identify a decent, inexpensive, and new source of oils that would be used locally and maybe industrially. Oil from watermelon seeds gives concentrated energy and increased flavor to the diet (50).

## ***PRUNUS AMYGDALUS AND CITRULLUS LANATUS IN APPLE PRESERVATION***

Apples have great flavor, firmness, color, and shelf life. However, the bitter pit (BP), caused by low Ca and high Mg tissue concentrations, is one of the most prevalent physiological problems in whole apple fruit. When fresh-cut, polyphenol oxidase on phenolic compounds causes enzymatic browning, affecting appearance, taste, and nutritional content and lowering product quality. These causes reduce fruit shelf life and increase storage chain waste (51). The freshness and safety of fruits and vegetables are determined mostly by their shelf lives, which can now be preserved without the use of potentially hazardous synthetic chemicals (52). Customers desire the use of natural preservatives and prefer fewer synthetic preservatives (34). Recently it was observed that bitter apricot oil and almond essential oil showed good preservative qualities, applied on apples whereas the essential oils incorporated with other materials in the form of film showed significant potency (53). EOs prevent the growth of fungi at the vapor phase, which is a crucial characteristic for food that is susceptible to immersion treatments (53).

Numerous people have experimented with various compounds to be used either before or after harvest to improve the time an apple may be stored. Postharvest loss, particularly in the fruit marketing chain, may be caused by several factors, but one of the most important is spoilage that occurs along the supply chain after harvest. At every point in the postharvest process, from harvesting to fieldwork to packing to shipping to storage, postharvest diseases may occur (54). It's believed that between 20 and 30 percent of harvested produce is lost once it's been delivered to stores. Cold storage is essential for preserving perishable produce like fruit and vegetables by postponing ripening-related changes such ethylene production, softening, color changes, respiration rate, acidity changes, and weight loss. Unfortunately, the quality of fruits and vegetables is not always maintained to an acceptable level throughout transit and marketing, despite the use of cold storage. This might result in the occurrence of severe chilling damage symptoms. As a result, we need to equip our cold storage facilities with the right postharvest technology (55).

People are always looking for new ways to get their hands on natural, minimally processed goods. One of the biggest obstacles facing the food business today is finding ways to cut down on the use of traditional chemical additives in food composition to meet these demands. Reducing the use of traditional

chemical additives in food composition is a significant problem facing the food industry as it tries to meet these demands. Since many plant-based products offer extra useful features, they are increasingly being considered as a source of inspiration for new applications (56).

A new approach to enhancing the microbiological stability of fresh-cut fruit has been presented, and it involves the use of antimicrobial agents like plant essential oils. Due to growing public awareness of the use of chemically manufactured chemicals in foods, there has been a notable rise in interest in the potential use of natural substances to limit microbial development (57). Essential oils are among the most thoroughly studied natural antimicrobials. A wide range of actions are shown by essential oils. As a result, these antimicrobials were effective against microbial species, food borne pathogens, and postharvest pathogens (58).

Essential oils have a lot of potential, but they aren't often used in food preservation because of their strong aroma and probable toxicity. The use of edible coatings as these natural substances' delivery systems would be an intriguing choice to reduce the necessary amounts. In the area of food preservation, edible coatings have lately gained more attention due to the positive outcomes. Food items' quality may be improved by biodegradable coatings (56).

Watermelon contains phytochemicals such as lycopene, vitamin C, beta-carotene, and total polyphenolic content. Regular use of these goods with antioxidant properties is essential for human health and well-being. Because of its high concentration of phytochemicals, watermelon seeds have great potential as a functional ingredient in food (59, 60). Compared to synthetic polymers, natural polymeric polysaccharides are biodegradable, non-toxic, inexpensive, and widely accessible in the environment, making them ideal for edible coatings in diverse foods (61).

Apple is the world's fourth most nutritious horticulture fruit. Due to its high moisture content, it has to be preserved. Edible natural antibacterial coatings are a novel way to preserve fruits. Gum-based edible coverings reduce respiration and oxidation by blocking CO<sub>2</sub> and O<sub>2</sub>. Gum-based coatings are extensively used to preserve fruit. Gum-coated apple fruit ripened later and decomposed slower than control samples (62, 63).

The physio-chemical, nutritional, and sensory properties of *Prunus amygdalus* have resulted in a significant rise in global demand for their consumption during the last decade (64). The almond tree, or *Prunus amygdalus*, produces gum that is only about 10% soluble in water and may range in color from colorless to light yellow to amber brown. The gum is taken in the fall from the main stem and bigger branches (52). The salt of an acidic polysaccharide, in which iron, calcium, and potassium serve to neutralize the acid groups, is another way to characterize it. On a dry weight basis, the gum substances of almond trees include 92.36 percent carbohydrates, 0.85% fat, 2.45% protein, and 2.45% fat. They include abundant amounts of minerals including calcium, iron, potassium, sodium, and magnesium (65). Yuvaraj *et al.*, 2016 done an experiment in which Fresh handpicked apples were bought from the nearest organic fruit shop and they were washed and dried. A few grams of almond gum were boiled in water and were completely melted. The melted tree gums were applied on the fruits. Uncoated orange and apple were left as a control for observing the number of days, the fruits can withstand decay. Almond gum (*Prunus amygdalus*) was tested on apples to see whether it may extend their freshness. For temperatures up to 273 degrees Celsius, almond gum maintains its thermal properties. By 273 C, the weight loss in almond gum is just about 16%. No mortality was found to be associated with almond gum. Consequently, establishing that eating almond gum is safe. To ensure the resins could work, researchers also retained some apples without coatings as a control. The Almond gum-coated apple delayed decay for almost 46 days, but the untreated apple rotted by day 6. They demonstrated that fruits coated with Almond gum are safe to consume and effective in extending their shelf life (52).



Fig. 5. Almond gum (adapted from Bouaziz et al., 2016)

## EDIBLE FILMS

Edible films and coatings have drawn attention as a promising technique that might extend the shelf life of fresh produce fruits while also enhancing their quality and lowering the risk of contamination (67). Proteins, polysaccharides, lipids, and their respective mixtures may be used to produce edible films and coatings. There is a clear preference for protein-based materials due to their nutritional benefits (68). Edible films are thin films made from edible material that protect the food from spoilage and damage due to environmental factors like moisture, oils, gases, and vapors. Edible films are often thin layers or solid sheets of food-safe material that have been manufactured and added to, or sandwiched between, different food products. Edible films have various benefits over synthetic materials, including being biodegradable and ecologically beneficial.

The presence of Hydrocolloids (water-soluble gums) have several uses in the food and pharmaceutical industries, including as coating agents, packaging films, emulsifiers, thickeners, texture modifiers, and stabilizers. Adding an edible coating on a fruit or other food item is a common way to keep it fresher for a longer period and improve its overall visual appeal. Some of the potential benefits of edible coatings made from natural gums include delayed ripening, longer storage life, reduced respiration rate, biocompatibility, lower production costs, reduced environmental impact, improved mass transfer barrier characteristics, and the ability to transport food additives like vitamins, antioxidants, and antimicrobials (69). Edible coatings reduce transpiration and weight loss by covering the stomata, as seen in apple, carrot, papaya, orange, guava, mango, plum, tomato, mushroom, banana, and apricot (70).

Edible films have often had lipids (fats and oils) added to them to boost their barrier qualities. The saturated fatty acids (palmitic, palmitoleic, and stearic) in almond oil are very low, whereas the mono-unsaturated fatty acids (particularly linoleic acid and oleic acid) are abundant. From a nutritional perspective, having a lot of oleic acid is a desirable quality. Foods that already contain lipids, such nuts, seeds, and meats, may benefit from hydrocolloid films and coatings created with the addition of liquid oil (71). Studies showed that the control films were clear and homogenous, whereas the films containing oils had an opaque appearance with a heterogeneous microstructure. Emulsified films demonstrated a higher degree of hydrophobicity, which was supported by a reduction in water vapor permeability and an increase in contact angle values. When oil and fat concentration rise, lipid droplet size decreases (71).

## CONCLUSION

The almond and watermelon seeds are good and cheap source of multiple bioactive compounds which provide numerous advantages in medicines, food and health industries. Almond seed oil has been used since long meanwhile watermelon seed oil neglected, which also possesses several properties including antifungal, antibacterial, antiviral, anti-spoilage, anti-inflammatory and antioxidant. Both oils contain bioactive compounds like alkaloids, flavonoids, phenolics etc. Due to the facts based upon previous studies these oils have good potency against many microorganisms and are capable of preserving food. These oils must be utilized as functional food, therapeutical and natural preserving agent.

### Recommendations:

Almond and watermelon seeds include bioactive substances, minerals (e.g. magnesium, copper, salt, potassium, iron, calcium, and zinc), vitamins (E and C), flavonoids, and phenols, making them both nutritional and medicinal. It has the capacity to prevent infections and treat some disorders. It has possessed extraordinary antifungal, antibacterial, antiviral, antiulcer, anticancer, anti-aging, antiparasitic anti-inflammatory, and antioxidant characteristics. It has multiple applications, including cosmetics, food additives, preservatives, and stabilizers. Its fruit, seed, leaves, and metabolites are useful for inhibiting bacterial, viral, and fungal growth, suppressing tumors, curing ulcers, parasite infections, skin infections, and protecting against a variety of organ problems.

Natural substances are safer, less expensive, and have less adverse effects than synthetic compounds. Both seeds contain many chemical elements that are helpful to human health, and these substances should be used in innovative medications. Its oil contains preservation properties. It can be used in a variety of ways to prevent food spoiling and loss.

### Authors' contribution:

FR Conceptualization and research experiments; ZH, MH Methodology; FR, ZH, MH Editing and review; ZH, MH Comparative analysis.

### Funding:

This study did not receive any funding or financial support.

### References:

1. Javaid T, Mahmood S, Saeed W, Qamrosh M. A critical review in varieties and benefits of almond (*Prunus dulcis*). *Acta Science Nutritional Health*. 2019;3(11):70-2.
2. Farooq M, Azadfar E, Rusu A, Trif M, Poushi MK, Wang Y. Improving the shelf life of peeled fresh almond kernels by edible coating with mastic gum. *Coatings*. 2021;11(6):618.
3. Potter D, Eriksson T, Evans RC, Oh S, Smedmark J, Morgan DR, et al. Phylogeny and classification of Rosaceae. *Plant systematics and evolution*. 2007;266(1):5-43.
4. Gupta E, Mishra P. Functional food with some health benefits, so called superfood: a review. *Current Nutrition & Food Science*. 2021;17(2):144-66.
5. Sultana B, Ashraf R. Watermelon (*Citrullus lanatus*) oil. *Fruit oils: Chemistry and functionality*. 2019:741-56.
6. Sangeeta GAN, Muzaffar K. Watermelon 17. *Antioxidants in Fruits: Properties and Health Benefits*. 2020:333.
7. Gabriel A, Igwemmar N, Sadam A, Babalola S. Characterization of seed oil from *Citrullus lanatus* (Watermelon). *Direct Research Journal of Public Health and Enviromental Technology*. 2018;3(2):34-40.
8. Mesías M, Palenzuela C, Olombrada E, Holgado F, Morales FJ. Acrylamide and hydroxymethylfurfural formation in roasted almonds (*Prunus dulcis*). *Food Control*. 2023:110140.
9. Ashraf M, Majeed A. Water requirements of major crops for different agro-climatic zones of Balochistan. 2006.

10. Abbas M, Ali S, Shah Ja, Hassan A, Malghani Al, Amin M, Et Al. Assesment Of Genetic Diversity On The Base Of Morphological Traits Among Elite Genotypes Of Watermelon (*Citrullus Sp.*) In Pakistan. *Plant Cell Biotechnology And Molecular Biology*. 2022:67-74.
11. FAOSTAT. Crops and livestock products. Food and Agriculture Organization of the United Nations; 2021.
12. Sajjad S, Israr B, Ali F, Pasha I. Investigating the effect of phytochemicals rich watermelon seeds against hypertension. *Pakistan Journal of Agricultural Sciences*. 2020;57(4).
13. Gupta A, Sharma R, Sharma S. Journal: Antioxidants in Vegetables and Nuts-Properties and Health Benefits, 2020, p. 423-452. *Journal: Antioxidants in Vegetables and Nuts-Properties and Health Benefits*. 2020:423-52.
14. Özcan MM. A review on some properties of almond: impact of processing, fatty acids, polyphenols, nutrients, bioactive properties, and health aspects. *Journal of Food Science and Technology*. 2022:1-12.
15. Singh R, Hasan SM, Ved A, Prakash O. An update on phytochemicals, nutritional composition, and pharmacological significance of *Prunus amygdalus batsch*: A comprehensive review. *Int J Pharm Sci Res*. 2022;13:1463-78.
16. Saleem M, Asif J, Asif M, Saleem U. Amygdalin from apricot kernels induces apoptosis and causes cell cycle arrest in cancer cells: an updated review. *Anti-Cancer Agents in Medicinal Chemistry (Formerly Current Medicinal Chemistry-Anti-Cancer Agents)*. 2018;18(12):1650-5.
17. Chen CY, Lapsley K, Blumberg J. A nutrition and health perspective on almonds. *Journal of the Science of Food and Agriculture*. 2006;86(14):2245-50.
18. Hussain F, Rakha A, Butt MS, Rizwan M. Comparative Analysis of Nutritional and Antioxidant Characteristics of Different Pakistani and Exotic Almonds. *Journal of Pharmaceutical Research International*. 2022:38-50.
19. Bailly C. Anticancer properties of *Prunus mume* extracts (Chinese plum, Japanese apricot). *Journal of ethnopharmacology*. 2020;246:112215.
20. dos Santos Baião D, Silva de Freitas C, Paes Gomes L, Da Silva D, Carolina NTF Correa A, Ribeiro Pereira P. Polyphenols from root, tubercles and grains cropped in Brazil: Chemical and nutritional characterization and their effects on human health and diseases. *Nutrients*. 2017;9(9):1044.
21. Oyeleke G, Olagunju E, Ojo A. Functional and physicochemical properties of watermelon *Citrullus Lanatus* seed and seed-oil. *Journal of Applied Chemistry*. 2012;2(2):29-31.
22. Gladvin G, Sudhaakr G, Swathi V, Santhisri K. Mineral and vitamin compositions contents in watermelon peel (Rind). *International Journal of Current Microbiology and Applied Sciences*. 2017;5(5):129-33.
23. Vandermark T. The Health Benefits of Watermelon Seeds. Retrieved Dec. 2011;9:2011.
24. Rekha G, Rose AL. Proximate nutritional analysis of dried watermelon seed. *Int J Eng Res Gen Sci*. 2016;4(6):44-6.
25. Collins JK, Wu G, Perkins-Veazie P, Spears K, Claypool PL, Baker RA, et al. Watermelon consumption increases plasma arginine concentrations in adults. *Nutrition*. 2007;23(3):261-6.
26. Ghodke S, Dhanke O, Dere U, Dhamdhare A. Development of Innovative Finger Millet-Watermelon Seed Powder Drink Mix.
27. Richardson DP, Astrup A, Cocaul A, Ellis P. The nutritional and health benefits of almonds: a healthy food choice. *Food Sci Technol Bull Funct Foods*. 2009;6:41-50.
28. RamzanA, Ozcan MM, Kanbur GS, Dursun N. Some physico-chemical properties of edible and forage watermelon seeds. 2012.
29. Azam SE, Abbas Z, Zahra R. Nutritional values of citron watermelon (*Citrullus lanatus* var. *citroides*): A Review. *Int J Global Sci*. 2022;4(1):2663.
30. Khalid W, Ikram A, Rehan M, Afzal F, Ambreen S, Ahmad M, et al. Chemical composition and health benefits of melon seed: A Review. *PJAR*. 2021;34:309-17.
31. Allaith S, Alfekaik D, Alssirag M, editors. Identification of *Pistacia vera* and *Prunus amygdalus Batsch* seed oils using GC-MS as useful methodology for chemical classification. *IOP Conference Series: Earth and Environmental Science*; 2019: IOP Publishing.
32. Oluba O, Ogunlowo Y, Ojeh G, Adebisi K, Eidangbe G, Isiosio I. Physicochemical properties and fatty acid composition of *Citrullus lanatus* (Egusi Melon) seed oil. *Journal of Biological Sciences*. 2008;8(4):814-7.
33. Alka G, Anamika S, Ranu P. A review on watermelon (*Citrullus lanatus*) medicinal seeds. *Journal of Pharmacognosy and Phytochemistry*. 2018;7(3):2222-5.

34. Akbaş P, Kol ÖG, Gürbüz A, Manap S. Anti-microbial and Anti-oxidant activity of watermelon (*Citrullus lanatus*) fruit and watermelon seed. *Celal Bayar University Journal of Science*. 2017;13(1):139-47.
35. Mehak A, Ajmal M, Shahbaz M, Nayyar BG, Seerat W, Fatima N, et al. Antifungal and antibacterial activity of oilseed cakes against soil-borne phytopathogens. *Pure and Applied Biology (PAB)*. 2023;12(2):1084-92.
36. Sulieman AME, Ibrahim SE. Antioxidant and pharmacological activity of watermelon (*Citrullus lanatus*) seed oil. *Multiple Biological Activities of Unconventional Seed Oils: Elsevier*; 2022. p. 185-94.
37. Patel MB. Water Melon-the Must Melon. *Pharmaceutical Research*. 2019;9(05).
38. Kashari O, Attah O, Muhammad H, Siddiku U, Yaqoob U, Abubakar A. Comparative Study of the Antibacterial Efficacy of Laboratory Produced Organic Cream from *Citrullus lanatus* Seed Oil and the Seed Oil against Some Clinical Bacteria Isolates.
39. Patel H, Rani K, Patani PJJPTCP. A review on role of herbs: New perspectives and potential health benefits of *Citrullus lanatus* and *Carica papaya* seeds. 2024;31(1):2189-22.
40. Ghadimi SN, Sharifi N, Osanloo M. The leishmanicidal activity of essential oils: a systematic review. *Journal of Herbmec Pharmacology*. 2020;9(4):300-8.
41. Guici El Kouacheur K, Cherif HS, Saidi F, Bensouici C, Fauconnier ML. *Prunus amygdalus* var. *amara* (bitter almond) seed oil: fatty acid composition, physicochemical parameters, enzyme inhibitory activity, antioxidant and anti-inflammatory potential. *Journal of Food Measurement and Characterization*. 2023;17(1):371-84.
42. Olatunde OG, Abidemi OR, Solomon BA, Ibukun OE, Oluwatimilehin II, Ayinke AB. Assessment of Anti-inflammatory Activity of *Prunus dulcis* [Miller DA Webb (ALMOND)] SEED Aqueous Extract and Fractions. *Egyptian Academic Journal of Biological Sciences, H Botany*. 2022;13(2):113-20.
43. Messaoudi S, Tebibel S, Beladjila AK, Touhami FK, Kabouche Z. Anti-hyperlipidemic, anti-inflammatory and antioxidant activities of *Citrullus lanatus*. *World Journal of Environmental Biosciences*. 2019;8(1):100-6.
44. Erhirhie E, Ekene N. Medicinal values on *Citrullus lanatus* (watermelon): pharmacological review. *International Journal of Research in Pharmaceutical and Biomedical Sciences*. 2013;4(4):1305-12.
45. Abdulkadir AR. In Vitro antioxidant activity of ethanolic extract from *Terminalia Catappa* (L.) leaves and fruits: Effect of fruit ripening. *Int J Sci Res*. 2015;4(8):1244-8.
46. Hussain SZ, Naseer B, Qadri T, Fatima T, Bhat TA. Almond (*Prunus dulcis*)—Morphology, Taxonomy, Composition and Health Benefits. *Fruits Grown in Highland Regions of the Himalayas: Springer*; 2021. p. 283-95.
47. Gayathri M, Chandrasekaran M, Radhakrishnan A, Kuppasamy G, Singh SK. Optimizing Badam gum towards tableting excipients. *Research Journal of Pharmacy and Technology*. 2020;13(12):6176-81.
48. Shragg T, Albertson TE, Fisher Jr CJ. Cyanide poisoning after bitter almond ingestion. *Western Journal of Medicine*. 1982;136(1):65.
49. Ahmad Z. The uses and properties of almond oil. *Complementary therapies in clinical practice*. 2010;16(1):10-2.
50. Alomary EAI. Effect of different levels of Watermelon (*Citrullus lanatus*) seeds powder on Chemical and sensory properties of set Yoghurt during storage: Sudan University of Science and Technology; 2019.
51. Farina V, Passafiume R, Tinebra I, Palazzolo E, Sortino G. Use of aloe vera gel-based edible coating with natural anti-browning and anti-oxidant additives to improve post-harvest quality of fresh-cut 'fuji'apple. *Agronomy*. 2020;10(4):515.
52. Yuvaraj D, Suvasin B. Resins as a Preservative for Fruits and Vegetables. *International Journal of Current Microbiology and Applied Sciences (IJCMAS)*. 2016;9:120-30.
53. Hamid Z, Hashim M, Gul Z, Akbar A. 7. Functional characteristics of bitter apricot seed kernel. *Pure and Applied Biology (PAB)*. 2023;12(1):434-48.
54. Prusky D. Reduction of the incidence of postharvest quality losses, and future prospects. *Food Security*. 2011;3(4):463-74.
55. Nouri M, Nasehi B, Samavati V, Mehdizadeh SA. Optimizing the effects of Persian gum and carrot pomace powder for development of low-fat donut with high fibre content. *Bioactive carbohydrates and dietary fibre*. 2017;9:39-45.
56. Sánchez-González L, Vargas M, González-Martínez C, Chiralt A, Chafer M. Use of essential oils in bioactive edible coatings: a review. *Food Engineering Reviews*. 2011;3(1):1-16.

57. Oms-Oliu G, Rojas-Graü, M. A., González, L. A., Varela, P., Soliva-Fortuny, R., Hernando, M. I. H, & Martín-Belloso, O. Recent approaches using chemical treatments to preserve quality of fresh-cut fruit: A review. *Postharvest biology and technology*, . 2010;57 (3):139-48.
58. Bakkali F, Averbeck S, Averbeck D, Idaomar M. Biological effects of essential oils—a review. *Food and chemical toxicology*. 2008;46(2):446-75.
59. Oyenihni OR, Afolabi BA, Oyenihni AB, Ojo GB. Toxicity assessment of watermelon seed supplemented diet in rats. *Drug and Chemical Toxicology*. 2021:1-8.
60. Dube J, Ddamulira G, Maphosa M. Watermelon production in Africa: challenges and opportunities. *International Journal of Vegetable Science*. 2021;27(3):211-9.
61. Asnaashari M, Mojahedi SM, Asadi Z, Azari-Marhabi S, Maleki A. A comparison of the antibacterial activity of the two methods of photodynamic therapy (using diode laser 810 nm and LED lamp 630 nm) against *Enterococcus faecalis* in extracted human anterior teeth. *Photodiagnosis and photodynamic therapy*. 2016;13:233-7.
62. El-Anany A, Hassan G, Ali FR. Effects of edible coatings on the shelf-life and quality of Anna apple (*Malus domestica* Borkh) during cold storage. *Journal of food technology*. 2009;7(1):5-11.
63. Salehi F. Rheological and physical properties and quality of the new formulation of apple cake with wild sage seed gum (*Salvia macrosiphon*). *Journal of Food Measurement and Characterization*. 2017;11(4):2006-12.
64. Loizzo MR, Tundis R, Leporini M, D'Urso G, Gagliano Candela R, Falco T, et al. Almond (*Prunus dulcis* cv. casteltermini) skin confectionery by-products: New opportunity for the development of a functional blackberry (*Rubus ulmifolius* schott) jam. *Antioxidants*. 2021;10(8):1218.
65. Mahfoudhi N, Chouaibi M, Donsi F, Ferrari G, Hamdi S. Chemical composition and functional properties of gum exudates from the trunk of the almond tree (*Prunus dulcis*). *Food Science and Technology International*. 2012;18(3):241-50.
66. Bouaziz F, Koubaa M, Ghorbel RE, Chaabouni SE. Recent advances in Rosaceae gum exudates: From synthesis to food and non-food applications. *International journal of biological macromolecules*. 2016;86:535-45.
67. Cerqueira M, Bourbon A, Pinheiro A, Martins J, Souza B, Teixeira J, et al. Galactomannans use in the development of edible films/coatings for food applications. *Trends in Food Science & Technology*. 2011;22(12):662-71.
68. Cao N, Fu Y, He J. Preparation and physical properties of soy protein isolate and gelatin composite films. *Food Hydrocolloids*. 2007;21(7):1153-62.
69. Salehi F. Edible coating of fruits and vegetables using natural gums: A review. *International Journal of Fruit Science*. 2020;20(sup2):S570-S89.
70. Vargas M, Pastor C, Chiralt A, McClements DJ, Gonzalez-Martinez C. Recent advances in edible coatings for fresh and minimally processed fruits. *Critical reviews in food science and nutrition*. 2008;48(6):496-511.
71. Galus S, Kadzińska J. Whey protein edible films modified with almond and walnut oils. *Food Hydrocolloids*. 2016;52:78-86.