

# Extraction of Flavonoids from Flavedo Layers of Citrus Fruits Peels and its Expected Anti-Diabetic and Psychological Significance; a Biochemical and Family Medicine Overview

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## Abstract

This study was aimed at Extraction of Flavonoids from Albedo layers of citrus fruits peels and its expected anti-diabetic significance. Lemon (*Citrus limon*) is the third most important species of citrus after orange and mandarin. Flavedo is the peel's outer layer. It is a rich source of essential oils. Albedo extract was separated. Study results clearly showed the presence ( $p \leq 0.05$ ) of flavonoids in Albedo citrus layers; peel > pulp > seeds. Flavonoids are the major constituents of dry citrus fruits as well as citrus peels. Citrus fruit prevents free radical generation and reduces homocysteine level; it also possesses anti-carcinogenic, anti-diabetic, anti-inflammatory properties. Flavonoids applications in medicinal chemistry includes anticancer, antioxidant, anti-inflammatory, and antiviral properties. They also have neuroprotective and cardio-protective effects.

**Keywords:** Anti-Diabetic; Anti-Inflammatory; Antioxidants; Citrus; Essential Oils.

## 1. Introduction

Flavedo is the peel's outer layer, whose color varies from green to yellow. It is a rich source of essential oils [21], which have been used since ancient times by the flavor and fragrance industry [23]. Albedo is the major component of lemon peel, and is a spongy and cellulose layer laid under flavedo. The thickness of the albedo fluctuates according to several variables, among them variety and degree of ripeness. Albedo has high dietary fiber content, and if added to new meat products permits to formulate healthier products like beef burgers, bologna and dry cured sausages [13]. In the present work, a low-cost agricultural waste material, lemon peel has been used for a source of protein, fats, and essential macro minerals necessary for the growth of animals is being investigated. Most of citrus plants are planted for consuming freshly at home. Orange and lemon fruits are consumed fresh or industrially processed as juice [15]. The juice industries produce mainly juices from the endocarp or pulp parts of citrus fruits. However, the industries discard byproducts including peels or flavedo, albedo, seeds and pulp residues as waste. The waste having more than half of the original weight of the fruit is disposed outside their compound which has high potential to affect the environment. All byproducts of citrus plants may have importance if they are recommended to use them based on research findings [18]. The chemical compositions of the plants are mainly affected by the part of plant analyzed, growing condition, variation of species, plant pretreatment, extraction methods, place of origin, maturity. The chemical constituents may present in all parts of the plant but the amount varies from one organ of plant to another [27]. Flavonoids are the major constituents of dry citrus fruits as well as citrus peels [18]. In the last decades of the 20th century, world production of citrus fruit has experienced continuous growth. Annual citrus production was totaled at an estimated 105 million tons in the period 2000–2004. Citrus fruits have a small edible portion and large amounts of waste materials such as peels and seeds and the peels are used in folk medicine for the management of degenerative diseases, such as diabetes and hypertension, though there is very limited information on the mode of action of these peels in the management of diabetes and hypertension. Reactive oxygen species attack and damage body cells to get the missing electron they need, but antioxidants protect the body by contributing an electron of their own, and in so doing, they neutralize free radicals and help prevent cumulative damage to body cells and tissues. Determination of the antioxidant potential of various natural components is being given greater importance so that they could replace synthetic antioxidants, whose use is increasingly restricted due to the secondary effects they may produce. Application of natural antioxidants in numerous foods has been reported by several researchers. Herbs and medicinal plants are costly and not easily available in all the seasons. Thus, cheap source of natural antioxidants would be an alternative source. Citrus fruits are an important source of bioactive compounds (flavonoids and vitamin C). It is round to oval in shape, orange colored, tight skinned and has a juice and sweet flesh. It can be eaten out-of-hand easily and is used as fresh ingredients in salads, in fresh juice and for juice concentrate. It can be sub-divided into four categories – round or common oranges, navel oranges, acid less oranges and blood oranges [10]. Grapefruit is probably a hybrid between the pummel and the sweet orange [16]. The chemical profiles that are characteristic of particular citrus species can be used to detect the authenticity of citrus juices in quality control [2].

## 2. Statistical analysis

Study results were statistically analyzed in accordance to SPSS version 2021, Anova, One sample T – test.

## 3. Materials and methods

Albedo extract was separated in accordance to the method described by [25]. The washed citrus peels were crushed in order to reduce their size. The edible portion and white spongy portion (albedo) were separated from the peel by crusher. The crushed samples were used to isolate an essential oil by hydro distillation as follows. Crushed pieces of lemon peels (225 g) were placed in to 1000 ml round bottom flask and 720 ml of distilled water was added to it. After addition of boiling chips, the flask was heated slowly for two hours. The distillate forms two layers in the Clevenger apparatus with organic compounds at upper and hydrosol at bottom. The organic phase was collected by small bottles and dried with anhydrous sodium sulfate. The weight of essential oil was measured and the percentage yield of oil was calculated [26].

## 4. Results

**Table 1:** Phytochemical Screening of Flavonoids (Mg /G Extract) Found in Flavedo Lemon Peel Layer.

Bootstrapa 95% Confidence Interval					
	Statistic	Bias Std	Error Lower	Upper	Statistic
Mean	49.087	0.005 e	0.543 e	48.213 e	49.960 e
Std. Deviation	1.3222	0.2345 e	0.3632 e	0.5774 e	0.5127 e

\* e. Based on 150 samples.

**Table 2:** Phytochemical Screening of Flavonoids (Mg /G Extract) Found in Flavedo Lemon Pulp Layer.

Bootstrapa 95% Confidence Interval					
	Statistic	Bias Std	Error Lower	Upper	Statistic
Mean	30.487 0.011	e 0.462 e	29.723 e	31.250 e	31.250 e
Std. Deviation	1.1552 0.1951 e	0.3114 e	0.5081 e	1.3221 e	1.3221 e

\* e. Based on 150 samples.

**Table 3:** Phytochemical Screening of Flavonoids (Mg /G Extract) Found in Flavedo Lemon Seed Layer

Bootstrapa 95% Confidence Interval					
	Statistic	Bias Std	Error Lower	Upper	Statistic
Mean	16.443 0.009 e	0 .587 e	5.490 e	17.397e	17.397e
Std. Deviation	1.4398 0.2456 e	0.823 e	0.6582 e	1.6512 e	1.6512 e

\* e. Based on 150 samples.

**Table 4:** Phytochemical Screening of Flavonoids (Mg /G Extract) Found in Flavedo Lemon Layers (Peel, Pulp and Seeds) Compared to Control

Test Value = 0 95% Confidence Interval of the Difference					
	t	Sig. (2-tailed)	Mean Difference	Lower	Upper
Control	26.495	0.000	28.6036	26.051	31.156
Peel	89.118	0.000	46.8135	45.571	48.056
Pulp	54.815	0.000	28.2439	27.025	29.462
Seeds	29.943	0.000	14.3336	13.202	15.466

\* P ≤ 0.05 is considered significant.

## 5. Discussions

Results in Table 1 clearly showed significant ( $p \leq 0.05$ ) presence of phytochemical flavonoids compounds in flavedo lemon peel layer, but no observed presence of phytochemical flavonoids compounds in albedo lemon peel layer. These findings are confirmed by [11], who stated that the fruit skin contains a higher concentration of antioxidant substances than the other parts of the fruit. Results in Table 2, clearly showed significant ( $p \leq 0.05$ ) presence of phytochemical flavonoids compounds in flavedo lemon pulp layer. Results in Table 3, clearly showed significant ( $p \leq 0.05$ ) presence of phytochemical flavonoids compounds in flavedo lemon seeds layer. Flavonoids concentrations were significant ( $p \leq 0.05$ ) higher in peel > pulp > seeds, as shown in Table 4. These results are confirmed by [14]. Phytochemicals are major bioactive compounds known for their health benefits. The peel extract contains very high amounts of alkaloids, flavonoids, and Steroids. Study results showed that plant phenolics not only exist in edible parts of plant but have also been found to exist in non - edible parts as in flavedo and albedo tissues in lemon peels. This result was in agreement with the study conducted by [6], who found That the total phenolic contents appear to follow predictable patterns over fruit maturation, occurring at the highest levels at the immature stage (189.77 and 176.31 mg /g extract in flavedo and albedo, respectively). Expected anti-diabetic significance of flavonoids are confirmed by [1], who stated that Fruit from Rutaceae plants is typically rich in phytochemicals, and these plants are the good sources of bioactive compounds that responsible for antioxidation and many other biological activities. Citrus fruit prevents free radical generation and reduces homocysteine level; it also possesses anti-carcinogenic, anti-diabetic, anti-inflammatory and anti-arthritis properties [22]. Expected anti-diabetic effects of Flavonoids has been confirmed by [17], who reported that quercetin possesses antidiabetic activity resulting in the regeneration of pancreatic islets and probably increases insulin release in streptozotocin-induced diabetic rats. Another study was in agreement with Expected anti-diabetic effects of Flavonoids, through stimulation of quercetin insulin release and enhanced  $Ca^{2+}$  uptake from isolated islets cell which suggest a place for flavonoids in noninsulin- dependent diabetes [5-4]. Free radicals or reactive oxygen species (ROS) are the outcomes of normal essential metabolic processes. Exposure to air pollutants, cigarette smoking, in-

dustrial chemicals, ozone and X-rays also contribute to the production of free radicals. The implication of free radicals and ROS exposure employs a multitude of biological effects covering many chronic diseases [12]. Thus, antioxidants are essential in protecting the human body from harmful effects of oxidation [24]. Citrus peel waste makes up around 50% to 70% of the w/w of processed fruits [7]. Biological activities in fruits mainly occur in the peel rather than the more heavily consumed fruit pulp [3]. The peels of citrus fruits are rich in flavonoids, phytochemicals which exhibit antioxidant activity and are described as a dietary bioactive [19]. Flavonoids and phenolic acids are the main classes of phenolic compounds found in Citrus fruits [8]. Citrus flavonoid contents and profiles vary significantly from one species to another [9]. Citrus peel, which represents between 50% and 65% of the total weight of the fruits, is a rich source of bioactive compounds, including natural antioxidants such as flavonoids [3]. Several studies showed that Citrus flavonoids are found to have anti-inflammatory, anti-cancer, anti-bacterial, anti-aging, and cardiovascular protection activities [20].

## 6. Conclusions

It is concluded that citrus peels are good sources of important nutrients and phytochemicals. Incorporation of Citrus maxima peel in food products for human consumption is important way to not only boast the flavor and acceptability of the product but also increase its phytochemical and nutrient densities. The food products can help reduce the risk of chronic diseases, such as D.M and promote physiological functions. It has been shown that citrus maxima peel is quite nutritive and have medicinal properties.

## 7. Recommendations

Study Recommendations can be summarized as follows:

- 1) Consideration of nutritional, pharmaceutical outlets of the discarded fruit parts.
- 2) The citrus bioflavonoids namely hesperidin and naringin both play crucial roles in controlling the progression of hyperglycemia.
- 3) Further studies on effectiveness of flavonoids as powerful anti-carcinogenic, anti-diabetic, anti-inflammatory agents.
- 4) Special emphasize on flavedo layers of citrus fruits as a rich source of flavonoids antioxidants, which is highly recommended as a good anti-diabetic agent.

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## 9. References

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