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RESEARCH ARTICLE

Comparative Analysis of Phenolic Compounds in Honey and *Momordica charantia* Linn

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ABSTRACT

Phenolic compounds are bioactive constituents in honey and *Momordica charantia*, contributing to their potential health benefits. Honey, a natural sweetener, contains phenolic acids, flavonoids, and other minor phenolic contents, contributing to its antioxidant activity and potential therapeutic properties. In this study, the High-Performance Liquid Chromatography (HPLC) technique was utilized to determine the phenolic content of *Momordica charantia* Linn and honey. The analysis of *Momordica charantia* Linn demonstrated that it showed the highest level of p-hydroxy benzoic acid, whereas the lowest quantity of p-coumaric acid was detected. Rutin was identified as the primary constituent in the composition of honey, whereas o-coumaric acid was detected in the lowest concentration. In conclusion, it can be concluded that *Momordica charantia* Linn and honey possess a significant abundance of phenolic compounds.

Keywords: Bitter melon, honey, *Momordica charantia* Linn, phenolic compounds

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Bal ve *Momordica charantia* Linn'deki Fenolik Bileşiklerin Karşılaştırmalı Analizi

ÖZ

Fenolik bileşikler, hem balda hem de *Momordica charantia*'da bulunan ve potansiyel sağlık yararına katkıda bulunan biyoaktif bileşenlerdir. Doğal bir tatlandırıcı olan bal, antioksidan aktivitesine ve potansiyel tedavi edici özelliklerine katkıda bulunan fenolik asitleri, flavonoidleri ve diğer küçük fenolik içerikleri içerir. Bu çalışmada *Momordica charantia* Linn ve balın fenolik içeriğini belirlemek için Yüksek Performanslı Sıvı Kromatografisi (HPLC) tekniğinden yararlanılmıştır. *Momordica charantia* Linn'in analizi, en yüksek düzeyde p-hidroksi benzoik asit içerdiğini, en düşük miktarda ise p-kumarik asitin tespit edildiğini göstermiştir. Balın bileşiminde rutin birincil bileşen olarak tanımlanırken, en düşük konsantrasyonda o-kumarik asit tespit edilmiştir. Sonuç olarak *Momordica charantia* Linn ve balın önemli miktarda fenolik bileşik içerdiği sonucuna varılabilir.

Anahtar Kelimeler: Bal, fenolik bileşikler, kudret narı, *Momordica charantia* Linn

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INTRODUCTION

The *Momordica charantia* plant, known as bitter melon or bitter gourd, is a flowering plant species belonging to *Cucurbitaceae* (Giuliani et al. 2016). This plant is widely used in traditional medicine. Due to its possible biological effects, the number of studies assessing its pharmacological activities has increased recently (Pundir and Chandel 2021). One of the components contributing to the health beneficial effects of M. charantia is phenolic compounds (Haque et al. 2011). Phenolic compounds are a class of secondary metabolites abundant in various plant species and known for their remarkable antioxidant and various other bioactive properties, including antibacterial activity (Qader et al. 2011). Numerous studies have examined its polyphenolic composition and potential biological properties for human well-being. Various extraction methods have been developed to obtain high amounts of polyphenolic compounds. Previous studies have shown that some extraction methods applied to bitter melon significantly increase the amount of phenolic compounds in the extract and, therefore, the antioxidant capacity (Ng and Kuppusamy 2019). The relationship between the phenolic content and antioxidant activity of extracts from M. charantia Linn suggests that phenolic compounds probably have a significant impact on its capacity to scavenge free radicals and reduce oxidative stress (Kubola and Siriamornpun 2008; Qader et al. 2011). Numerous researches have provided evidence suggesting that it has antimicrobial activity (Sood et al. 2012). In addition to its antimicrobial properties, M. charantia Linn has been reported to have antidiabetic, wound-healing, and immunomodulatory activities (Prasad et al. 2006; Meng et al. 2012; Tan et al. 2016). Additionally, the number of studies examining the effects of bitter melon on cancer has started to increase recently (Yasui et al. 2005; Semiz and Sen 2007; Dia and Krishnan 2016).

Honey, a naturally occurring sweet substance, has gained extensive usage as a dietary commodity due to its potential for promoting health and well-being. Current research has emphasized honey's impact on cognitive function, specifically exploring its ability to enhance memory, defend against neurological damage, alleviate stress, and reduce pain sensitivity (Zamri et al. 2023). Furthermore, it has been found that honey has a regulatory influence on the microbiota in the human gastrointestinal tract, facilitating the proliferation of advantageous bacteria while inhibiting the growth of potentially harmful microorganisms (Jiang et al. 2020). The antioxidant properties of honey are ascribed to the existence of phenolic compounds, which facilitate the neutralization of detrimental free radicals and the alleviation of oxidative damage (Moniruzzaman et al. 2013). Furthermore, honey has been found to exhibit immunomodulatory effects, particularly in the context of skin disordersResearch studies have demonstrated that honey possesses the ability to inhibit the proliferation of bacteria that are of significance in the field of dermatology, as well as influence immunological factors associated with the skin's immune system (McLoone et al. 2015). This study aims to provide an analysis of the phenolics found in honey and *Momordica charantia*, with a particular focus on their varied health benefits and potential therapeutic applications.

MATERIALS and METHODS

Providing materials

The honey and *Momordica charantia* were bought at a local market in the Burdur Province of Turkey. Twenty-three standard phenolics (Table 1) were obtained from Sigma-Aldrich, Inc. (St. Louis, MO) to serve as standards in the HPLC analysis of individual phenolics.

Phenolic content analysis

The phenolic contents of *Momordica charantia* Linn and honey were evaluated using high-performance liquid chromatography (HPLC, Shimadzu, Japan) with the conditions specified in Table 2 (Horax et al., 2010). The bitter melon fruits and honey samples were subjected to HPLC analysis following the methods described by Horax et al. (2010) and Estevinho et al. (2008).

Table 1. Phenolic contents of *Momordica charantia* Linn and honey.

Phenolic compounds	***Momordica charantia* Linn**	Honey
Gallic Acid	1.9	*
Protocatechic Acid	*	*
Catechin	*	*
p-hydroxy benzoic acid	6.7	*
Chlorogenic acid	0.8	2.6
Caffeic acid	0.2	0.5
Epicatechin	*	*
Syringic Acid,	0.3	0.2
Vanilin	*	*
p-coumaric acid,	0.05	0.3
Ferulic acid,	*	0.5
Sinapinic acid,	*	*
Benzoic acid,	*	0.7
o-coumaric acid,	*	0.1
Rutin	*	9.7
Hesperidin	*	0.2
Rosmarinic acid,	*	*
Eriodictiol	*	*
Cinnamic acid	0.1	0.2
Quercetin	0.5	1.8
Luteolin	0.3	1.3
Kamferol	1.1	1.1
Apigenin	*	*

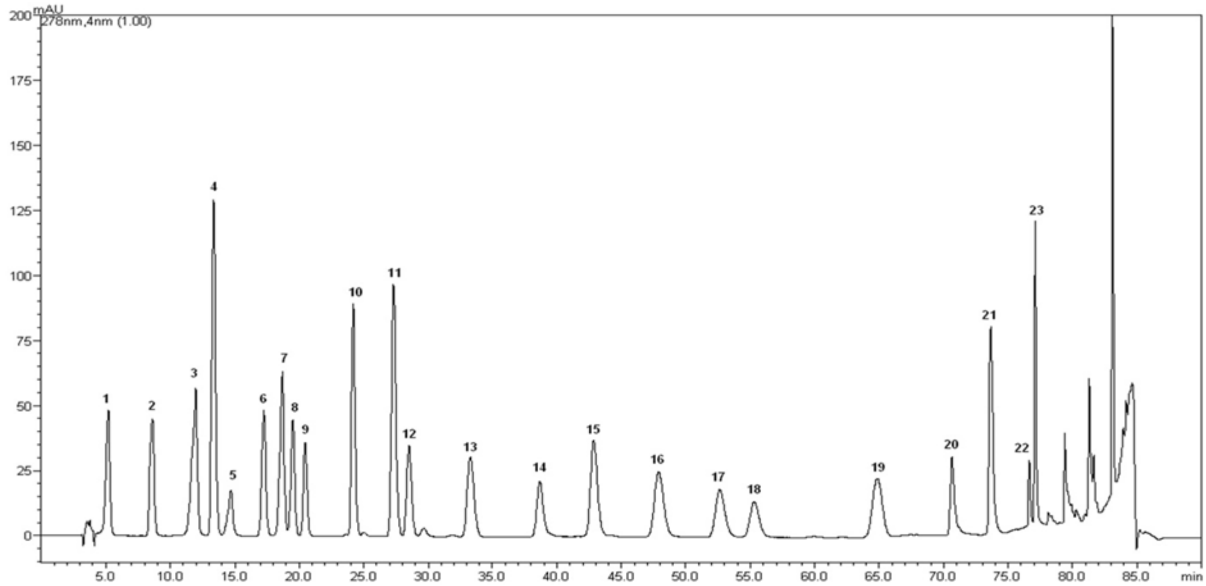
*"Non detected"

Table 2. The high-performance liquid chromatography (HPLC) parameters used for the analysis of phenolic content.

Condition	**Settings**
Dedector	SPD-M 10A vp DAD dedector (λmax=278nm)
Auto sampler	SIL–10AD vp
System controller	SCL-10Avp
Pump:	LC-10ADvp
Degasser	DGU- 14A
Column oven:	CTO-10Avp
Column	Agilent Eclipse XDB-C18 (250 × 4.60 mm) 5-micron
Column temperature	30^0C
Mobile phase	A: 3% acetic acid, B: methanol
Injection Volume	20 µl
Flow Rate	0.8 $ml.min^{-1}$

RESULTS

The phenolic composition of bitter melon and honey is presented in Table 1. The analysis of *Momordica charantia* Linn revealed that it had the highest concentration of p-hydroxy benzoic acid, while the lowest quantity of p-coumaric acid was detected. The predominant component in honey composition was rutin, while o-coumaric acid was found in the lowest concentration. Figure 1 indicates the chromatogram of standards, and Figure 2 shows the chromatogram of *Momordica charantia* Linn and honey.



1: Gallic acid, 2: Protocatechic acid, 3: Catechin, 4: p-hydroxy benzoic acid, 5: Chlorogenic acid, 6: Caffeic acid, 7: Epicatechin, 8: Syringic acid, 9: Vanilin, 10: p-coumaric acid, 11: Ferulic acid, 12: Sinapinic acid, 13: Benzoic acid, 14: o-coumaric acid, 15: Rutin, 16: Hesperidin, 17: Rosmarinic acid, 18: Eriodictiol, 19: Cinnamic acid, 20: Quercetin, 21: Luteolin, 22: Kamferol, 23: Apigenin

Figure 1: The chromatogram of standards

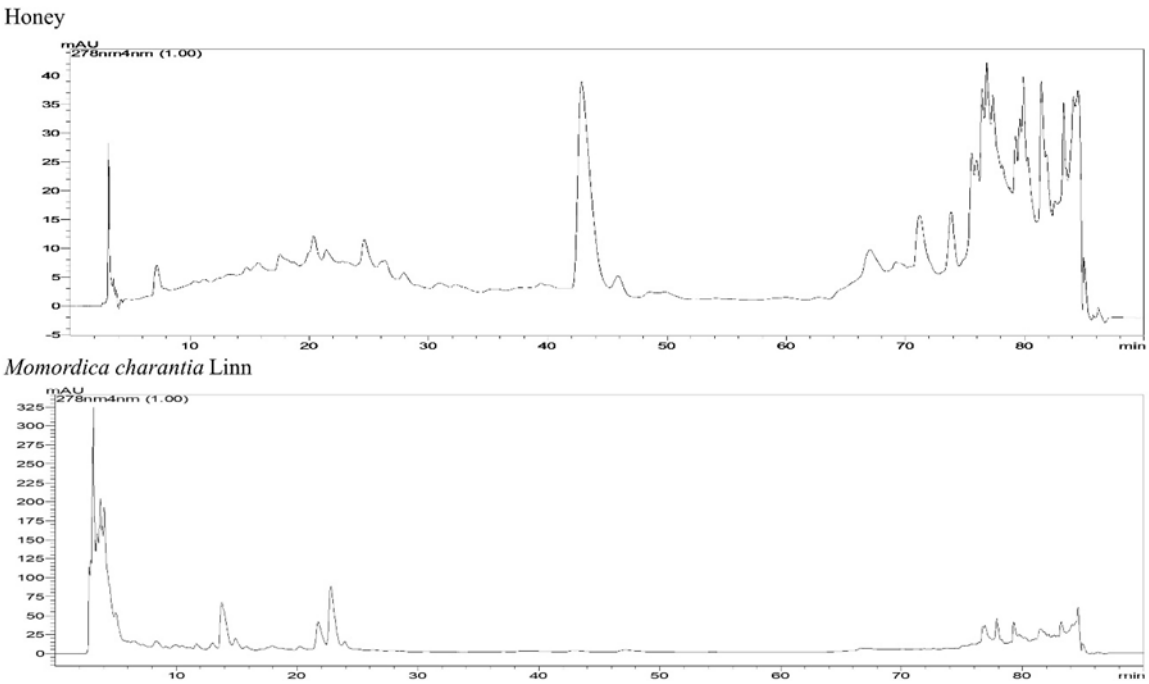


Figure 2: The chromatogram of *Momordica charantia* Linn and honey

DISCUSSION

Phenolic compounds are a class of bioactive chemicals renowned for their antioxidative characteristics and prospective contributions to human health. *Momordica charantia* Linn, commonly called bitter melon or bitter gourd, has been the subject of much research due to its abundance of phenolic compounds and the subsequent health benefits they may provide. Numerous evaluations have been reported to investigate the phenolic compounds present in Momordica charantia Linn by utilizing High-Performance Liquid Chromatography (HPLC). (Sagor et al. 2015; Huang et al. 2015; Kenny et al. 2013; Tan et al. 2014; Busuioc et al. 2020). Numerous phenolic compounds, including p-hydroxy benzoic acid, chlorogenic acid, caffeic acid, syringic acid, p-coumaric acid, sinapinic acid, cinnamic acid, quercetin, luteolin, and kamferol, have been identified in *Momordica charantia* through these investigations. For instance, Sagor et al. (2015) analyzed the phenolic compounds in *Momordica charantia* Linn and found abundant quantities of ellagic acid and myricetin. In their study, Huang et al. (2015) analyzed the chemical composition of *Momordica charantia* Linn leaves and detected ten phenolic compounds. A study has demonstrated the occurrence of diverse phenolics, like quinic acid, quinic acid, and catechin, in *Momordica charantia* (Kenny et al. 2013). These studies propose scientific evidence for phenolic chemicals in *Momordica charantia*. The antioxidant activity of phenolic compounds has been demonstrated, indicating its potential to reduce oxidative stress and prevent the development of many diseases (Sagor et al. 2015). The capacity of phenolic compounds to eliminate free radicals and prevent oxidative damage is responsible for their antioxidant action (Garcia et al. 2020). Furthermore, it has been documented that phenolic compounds possess anti-inflammatory, antibacterial, and anticancer characteristics (Owusu et al. 2021; Muronga et al. 2021).

Honey includes many phenolic compounds (Estevinho et al. 2008). Chlorogenic acid, a common phenolic molecule, is abundantly present in coffee beans and is recognized for its notable antioxidant properties (Nardini et al. 2002). It can also be found in honey and has been demonstrated to have advantageous impacts on human well-being (Sato et al. 2011). Caffeic acid, a chlorogenic acid derivative, is a phenolic molecule detected in honey and has demonstrated a higher level of antioxidant activity than chlorogenic acid (Sato et al. 2011). These substances have been documented to demonstrate antioxidant and antibacterial properties and possess antioxidant capacity (Estevinho et al. 2008; Huang et al. 2012). Additionally, it has been documented that quercetin and luteolin possess antioxidant and antibacterial properties (Sarker and Oba 2019). In general, the existence of these phenolic chemicals inside honey contributes to enhancing its antioxidant and antibacterial characteristics. The antioxidant potential of honey is dependent on the quantity of phenolic compounds, whereas black honey often exhibits more activity compared to clear honey (Estevinho et al. 2008). These substances also contribute to the biological activity exhibited by honey, including its antibacterial and wound-healing qualities (Wadi 2022).

CONCLUSION

In conclusion, *Momordica charantia* Linn is a plant species that contains various phenolic compounds. Phenolic compounds in *Momordica charantia* are responsible for their antioxidant properties and potential health benefits. In this study, various phenolic components were detected in honey. These substances are responsible for honey's antioxidant, antibacterial, and other biological actions. Additional investigation is required to comprehensively comprehend the mechanisms of action and potential health advantages associated with the phenolic chemicals in honey and *Momordica charantia*.

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Ethical approval: "This study is not subject to the permission of HADYEK in accordance with the "Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees" 8 (k). The data, information and documents presented in this article were obtained within the framework of academic and ethical rules."

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