World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(RESEARCH ARTICLE)

Check for updates

Determination of some Biochemical Properties of *Taraxacum scaturiginosum* and *Asparagus officinalis* extracted with *Lactobacillus plantarum*

AYSE NILAY GUVENC [1,*] and SEVDA KIRBAG [2]

[1] *Vocational School of Health Services, Adiyaman University, Adiyaman/Turkey.*
[2] *Department of Biology, Faculty of Science, Firat University, Elazig, /Turkey.*

World Journal of Biology Pharmacy and Health Sciences, 2024 20(02), 627–636

Publication history: Received on 02 October 2024; revised on 12 November 2024; accepted on 14 November 2024

Article DOI: https://doi.org/10.30574/wjbphs.2024.20.2.0895

Abstract

In this study analyzed the effects of *Taraxacum scaturiginosum* (T) and *Asparagus officinalis* (A) on *Lactobacillus plantarum* (Lp). In the study, fatty acid, flavonoid, resveratrol content, vitamin, phytosterol levels and the antimicrobial activities of T and A the fatty acid, flavonoid, resveratrol content, vitamin, phytosterol levels and antimicrobial activities of Lp extracts treated with T and A were determined and compared. For this purpose, the control (T and A), Lp treated with T and A (T+Lp, A+Lp) and Lp only cultures were used. According to experimental results; the fatty acid of the T (dandelion) and A (asparagus) extracts significantly increased after being treated with Lp whereas in the controls that the flavonoid and resveratrol levels decreased while the antimicrobial activity showed variations. Some vitamin levels of extracts significantly decreased after being treated with Lp whereas in the controls. A herbal diet is recommended to maintain the vitality of probiotic bacteria, which are necessary for a healthy life

Keywords: *L. plantarum*; *T. scaturiginosum*; *A. officinalis*; Probiotic bacteria; Prebiotic

1. Introduction

Keeping pathogenic bacteria under control requires the use of probiotic bacteria. Probiotics are very effective on human health, they have very important roles in the immune system, in fighting pathogens, and in protecting and healing the intestinal epithelium [1]. Probiotics compete with pathogenic microorganisms and cling to the intestinal walls. They stop the development of pathogens with the substances they secrete. The goal of probiotics is to reduce the number of pathogens and strengthen immunity. [2]. The importance of prebiotics is indisputable as much as probiotics because there is a symbiotic relationship between them. [3]. As is known, prebiotics are indigestible carbohydrates that activate probiotic development and thus contribute to human health. [2]. It promotes the development of beneficial microflora in the intestine, has a positive effect on regular and healthy digestion, increases mineral absorption, strengthens the immune system, [4] inhibits the proliferation of pathogenic bacteria, has a laxative effect, reduces the risk of diarrhea and colon cancer. It has been observed that they produce various fatty acids when used as a carbon source in the intestinal flora (such as propionic acid, lactic acid and acetic acid). [5]. These fatty acids increase intestinal acidity and increase mineral absorption. The compounds released as a result of fermentation also provide energy sources for intestinal epithelial cells. [6]. In recent years, it has been determined that there is an increase in the number of Bifidobacteria and a decrease in the number of pathogens in the intestinal microflora in prebiotic nutrition [5]. It has also been stated that there is an increase in fecal lactobacilli numbers with prebiotic nutrition. [7].

This study, the effects of T and A, which are known to have prebiotic effects, on Lp were investigated. Some phytochemical contents of this bacteria extracted with the plant were tried to be determined. In this study, the effects of the plant samples used on Lp development and therefore on human health were investigated. As a result, the

* Corresponding author: AYSE NILAY GUVENC

importance of the effect of plant nutrition on probiotic bacteria was emphasized. As a result, the importance of the effect of herbal nutrition on probiotic bacteria is emphasized.

2. Material and methods

66032 (Cg) and 2 Dermatophytes *Trichophyton* spp. (Tr) and *Epidermophyton* spp. (Ep) were used in the study. The microorganisms were supplied by Microbiology Laboratory Department of Biology, Faculty of Science, Fırat University. Lp were supplied by Department of Biology, Anadolu University.

2.1. Preparation of Microorganisms Cultures and Cultivation

Bacteria strains were inoculated with a nutrient broth and were incubated at 35±1°C for 24 h. Yeast strains were incubated in Malt Extract Broth-Agar, while the dermatophyte fungi were incubated in Sabouraud Glucose Broth at 25±1°C for 48 h. The culture growing in the liquid medium was transferred to the broth tubes after performing turbidity adjustment according to a McFarland (0.5) standard tube. Müller Hinton Agar, Sabouraud Dextrose Agar and Potato Dextrose Agar which were sterilized in an erlenmayer flask and cooled to 45-50°C were inoculated with the cultures of bacteria, yeast and fungi in the broth at 1% proportion (10^6 bacteria/ml, 10^4 yeast/ml, 10^4 fungus/ml). After shaking well, a homogenous medium was obtained and 15 ml of the mixture was placed in petri dishes of 9 cm diameter. The soaked discs were placed on solidified agar and The plant samples used in our study were taken from Fırat University campus, Elazığ and Antalya city center, placed in sterile bags and stored in a deep freezer at -20ºC until analysis.

2.2. Extraction of lipids

Cell pellets whose wet weights were determined were homogenized with 3/2 (v v^{-1}) hexaneisopropanol mixture. The homogenate was centrifuged at 5000 rpm for 5 min at 4 °C and cell pellet remnant was precipitated. The supernatant part was used in the vitamin and fatty acid analysis [8].

2.3. Preparation of fatty acid methyl esters

An aliquot was taken from the supernatant part of the cell pellet and 5 ml of 2% methanolic sulphuric acid was added. The mixture was vortexed and then kept at 50 ºC for 12 hours. Then, after being cooled to room temperature, 5 ml of 5% sodium chloride was added and then it was vortexed. Fatty acid methyl esters were extracted with 2x5 ml hexane. Fatty acid methyl esters were treated with 5 ml 2% KHCO3 solution and then the hexane phase was evaporated by the nitrogen flow, and then by dissolving in 1 ml fresh hexane, they were taken to auto sampler vials [9].

2.4. Gas chromatographic analysis of fatty acid methyl esters

Methyl esters were analyzed with the SHIMADZU GC 17 Ver. 3 gas chromatography (Kyoto, Japan). For this analysis, 25m of long Machery-Nagel (Germany) capillary colon with an inner diameter of 0,25µm and a thickness of 25 micron film was used. During the analysis, the colon temperature was kept at 120-220 ºC, injection temperature was kept at 240 ºC and the detector temperature was kept at 280 ºC. The colon temperature program was adjusted from 120 ºC to 220 ºC and the temperature increase was determined to be 5 ºC/min until 200 ºC and 4 ºC/min from 200 ºC to 220 ºC. It was kept at 220 ºC for 8 minutes and the total duration was set as 35 min and nitrogen gas was used as the carrier gas. During the analysis, before the analysis of fatty acid methyl esters, mixtures of standard fatty acid methyl esters were injected and the residence time of each fatty acid was determined. After this process, the necessary programming was made and the fatty acid methyl esters mixtures of the samples were analyzed [8].

2.5. HPLC analysis of adek vitamins and sterol amount

The five ml supernatant was taken to 25 mL tubes with caps and 5% KOH solution was added. After it was vortexed, it was kept at 85°C for 15 min. The tubes were then taken and cooled to room temperature and 5 mL of pure water was added and mixed. Lypophlic molecules that did not saponify were extracted with 2x5 mL hexane. The hexane phase was evaporated with nitrogen flow. İt was dissolved in 1 mL (50+50%, v v^{-1}) acetonitril/methanol mixture and then was taken to auto sampler vials and was analyzed. The analysis was made with the Shimadzu brand HPLC device. In the device as the pump LC-10 ADVP UV-visible, as the detector SPD-10AVP, as column oven CTO-10ASVP, as auto sampler SIL-10ADVP, as degasser unit DGU-14A and Class VP software (Shimadzu, Kyoton Japan) was used and during the mobile phase the acetonitril/methanol (60+40% v v^{-1}) mixture was used. The mobile phase flow rate was determined to be 1 mL A Uv detector was used for the analysis and as a column the Supelcosil LC 18 (15x4.6 cm, 5 µm; Sigma, USA) column was used. For vitamin A and beta-charoten, detection of wave length 326 nm, for vitamin D and K, 265 nm, for vitamin E, 202 nm was used [9].

2.6. Statistical Analysis

The SPSS 10.0 software program was used. The comparison between experimental groups and the control group was made using ANOVA and LSD tests [8].

2.7. DPPH Radical Scavenging Activity

A methanolic solution of 25 mg/L free radical DPPH was prepared. During the tests, plant samples of 25, 50, 100 and 250 µL concentrations were added to the methanolic solution of 3.9 ml DPPH radical. The mixture was vortexed and incubated for 30 minutes at room temperature in a dark medium. The absorbance values were measured using a spectrophotometer at 517 nm against a blank [10,11]. Radical scavenging activity was calculated as a %. The DPPH radical scavenging activity was calculated using the following formula: (%)= [(Controlλ–Samplingλ)/(Controlλ)]x100

2.8. Identification of Resveratrol and Flavonoid Content

The flavonoid and resveratrol analysis was performed in an HPLC device and all procedures were performed at 25° [12].

2.9. Extraction and Analysis of Phytosterols

To the plant sample which was homogenized with hexane/isopropyl alcohol mixture (in proportion of 3/2 v/v) 5% KOH was added and it was hydrolyzed at 85ºC. The extraction was treated with n-heptane and analyzed in an HPLC device [13].

2.10. Sugar Analysis

The 10 g plant sample was homogenized with distilled water. Then, the pellet and supernatant sections were separated. After the identification of the volume of the total filtrate, it was analyzed in an HPLC device and a Shim-Pack HRC NH2 (150x4.6 mm, 5 µ) colon was used. Acetonitrile+water (v/v) (7%5/25%) mixture was used as the mobile phase [13].

2.11. Antimicrobial Activity

2.11.1. Test Microorganisms

A total of 4 bacteria (*Bacillus megaterium* DSM 32 (Bm), *Staphylococcus aureus* COWAN 1 (Sa), *Escherichia coli* ATCC 25922 (Ec) and *Klebsiella pneumoniae* FMC 5 (Kp), 2 yeasts *Candida albicans* FMC 17 (Ca) and *Candida glabrata* ATCC lightly pressed. The petri dishes prepared in this manner were maintained at 4°C for 1.5-2 h. The plates inoculated with bacteria were incubated at 37±1°C for 24 h; the plates inoculated with yeast and dermatophyte were incubated at 25±1°C for 3 days. At the end of these periods, the inhibition zones that formed on the medium were evaluated as mm [14]

2.11.2. Growth of Lp and Treatment with Plant Extraction

After growing Lp, in the MRS broth, and measuring it at spectrophotometer against a blank at 517 nm, it was cultivated in the environment containing the prepared minimal medium (0.019 M NaCl, 0.022 M KH_2PO_4, 0.049 M Na_2HPO_4, 0.019 M NH_4Cl, 0.002 M $MgSO_4$, 0.011 M glucose) [15] and the plant extract (the plant sample was treated with a solvent and evaporated in evaporator, favorable growth media was prepared for the bacteria) at a level of 10^6 bacteria/ml under sterile conditions and an appropriate value was achieved. It was measured at spectrophotometer against blank at 517 nm. After incubation, the extracts which had been grown in the minimal medium were collected and measured in spectrophotometer against a blank at 517 nm for 6 h, 12 h, 24 h, 36 h, 48 h, 60 h and 72 h. After the measurements, the extracts were cultivated and incubated in MRS agar for the cell and plate count. The samples were centrifuged and pellets were collected at the point where growth was about to end. The fatty acid, vitamin, flavonoid, resveratrol and antimicrobial activities of these pellets were analyzed. The same procedures were applied to the Lp and plant (T and A) control group grown only in the minimal medium. In conclusion, the control (only plant) and Lp extract which was treated with plant were compared in terms of fatty acid and vitamin antimicrobial activity.

3. Results and discussion

3.1. Free Radical (DPPH) Neutralization Activity

It was determined that T. showed DPPH scavenging activity at a maximum concentration of 25 µl and a minimum of 250 µl. It was observed that A. was most effective at a maximum concentration of 250 µl. ($p<0.0001$). It was observed that both plants used in the study had DPPH scavenging activity. Plant phenols have been shown to have the ability to inhibit and neutralize superoxide, alkyl and hydroxyl free radicals that damage DNA and other cell components [16]. It has been shown that dandelion leaves contain apigenin and luteolin and have strong antioxidant properties, and dandelion is effective against DPPH radicals [17,18].

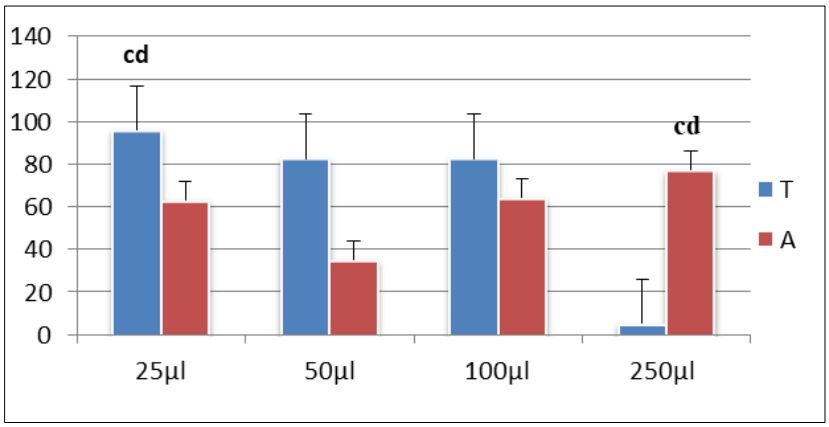


Figure 1 DPPH radical scavenging activity T and A (µl)

3.2. Sugar contents

When the plant extracts were examined in terms of sugar content, it was determined that fructose was at significant levels in T. and arabinose in A. (Table 1). A study has determined that dandelion contains fructose [19]. A study on asparagus has reported that it lowers the amount of sugar in the blood and reduces the need for insulin, helps establish fluid balance in the body, regulates blood pressure, cleans the blood and ensures the regular functioning of the liver and kidneys [20].

Table 1 Sugar contents of plant extracts used in the study (µg /1 g)

Samp.	Glucose	Fructose	Arabinose	Sucrose	Maltose
T	-	0,263±0,00	-	0,057±0,00	0,0121±0,00
A	0,035±0,00	0,0537±0,00	0,019±0,00cd	0,0003±0,00	0,0212±0,00

T.scaturiginosum (T) and *A. officinalis* (A) (cd: $p<0.0001$).

3.3. Fatty acid contents

The increase in palmitic acid (16:0), palmitoleic acid (16:01), stearic acid (18:0), oleic acid (18:1), linoleic acid (18:2), linolenic acid (18:3) and total fatty acid levels (T+Lp. and A+Lp) of the extracts compared to the control (T and A) indicates that dandelion and asparagus play a stimulating role for Lp development. It can be said that the mechanism causing this increase is related to the activating effect of the available carbon source of the plants used on the enzymes that control fatty acid synthesis.

In other words, it should be considered that fatty acid synthesis in the cell is affected by the carbon source in the environment. The increase in some fatty acid levels of Lp extracted with T and A (T+Lp and A+Lp) compared to the control (T and A) indicates that the plant extract is an environment that activates the growth of Lp. The decreasing fatty acid levels in the extracts are thought to be consumed by these bacteria and are a necessary nutrient for the viability of probiotic bacteria (Table 2).

Table 2 Lp. treated with T. and A. fatty acid (f.a.) levels and comparison (µg/1g)

Örn.	**16:0**	**16:01**	**18:0**	**18:1**	**18:2**	**18:3**	**Total(f.a.)**
T	42.60±0	-	76.29±0	-	-	384.39±0	502.90±0.20
T+Lp	301.66±1.66^{cd}	311.66±0.66^{cd}	313.66±1.33^{cd}	24.33±0.66	355.66±0.66^{cd}	295.66±0.66^{d}	1602.66±1.66^{cd}
A	46.16±0.06	-	-	14.76±0.03	79.36±0.03	18.76±0.03	159.06±0.03
A+Lp	82.05±15.31^{d}	-	100.55±5.73^{d}	90.56±36.14^{cd}	388.32±288^{cd}	73.21±33.11^{cd}	734.69±367^{cd}
Lp	20.21±0.68	-	26.76±8.13^{b}	32.53±0.23	59.43±3.26	38.33±3.33	177.28±11.51

(T+Lp: Dandelion+*L.plantarum*, T: Control, A+Lp: Asparagus+*L.plantarum*, A: Asparagus, Lp: *L. plantarum*), (**cd: p<0.001**).

3.4. Lipophilic vitamin and phytosterol contents (L.V.F)

It was determined that the levels of α-tocopherol, retinol, K1, K2 and vitamin D decreased in Lp. (T+Lp) samples extracted with T compared to the control (T), and the levels of δ-tocopherol and ergosterol, stigmasterol, and β-sitosterol partially increased. Studies have shown that dandelion contains vitamins A, C and E, and 25 grams of dandelion leaves contain 7000 units of vitamin A, B and C vitamins [21]. In a study, it was observed that dandelion, which is a food rich in calcium and other minerals, especially potassium, contains vitamins A and C, and contains compounds such as torexacin, retinol, levulin and inulin. It has also been stated that dandelion is used as a diet, gives strength and vitality to the body, and also supports the liver and prevents edema formation by removing excess water accumulated in the body [22]. This increase resulting from the combination of bacteria and plants was thought to be due to the increase in all parameters except vitamin K2 and stigmasterol in samples extracted with A (A+Lp) compared to control (A). According to these results, the plant provides an environment for bacterial growth and the bacteria evaluate this environment and increase the amount and variety of beneficial compounds in favor of vitality. If the reduction is meant, it is said that the bacteria use the compound in the environment for their growth and maintain their vitality, indirectly achieving a positive result.

In the study, it was thought that both results regarding the increase or decrease of the compounds in the environment were positive for health. Because if what is meant is the increase of compounds in the environment; It says that bacteria produce and the rate of beneficial compounds increases. If what is meant is a decrease, it can be said that the bacteria use the compound in the environment for their growth and continue their vitality, and indirectly a positive result is achieved. In a study, it was stated that Asparagus is low in calories, contains vitamins A, B1, B2, B6, folic acid, vitamin C, keratin and various fibers. It has been determined that a bowl of boiled asparagus meets 66 percent of the body's daily vitamin B needs, is a food source that is poor in Na and rich in K, also contains folate (vitamin B), protein, sugar, fat and various minerals, eliminates edema caused by heart diseases and eliminates swelling in the hands and feet [20].

Table 3 Lipophilic vitamin and phytosterol levels of T and A treated Lp compared to control and comparison (µg/1g)

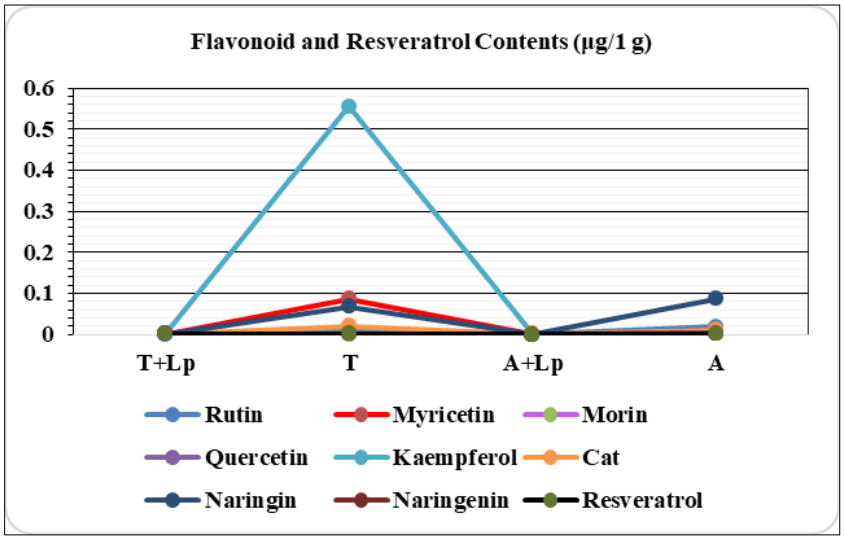
L.V.F	**T**	**T+Lp**	**A**	**A+Lp**	**Lp**
δ-tokoferol	0.0748±0.073	0.0519±0	0.0001±0	0.0020±0	0.0018±0^{cd}
Vitamin D	0.0224±0.011	0.0080±0^{cd}	0.0008±0	0.0173±0^{d}	0.0010±0
α-tokoferol	0.240±0.01	0.0208±0^{d}	0.0002±0	0.145±0^{d}	0.0108±0^{cd}
Vitamin K1	0.0253±0.005	0.0023±0^{cd}	0.0003±0	0.0151±0^{d}	0.0047±0
Vitamin K2	0.0038±0.003	0.0023±0	0.0002±0	0.0013±0	0.0007±0^{cd}
Ergosterol	0.0280±0.006	0.0867±0^{cd}	0.0044±0.004	0.0110±0^{d}	0.1418±0^{cd}
Stigmasterol	0.0585±0.021	0.407±0^{d}	0.0298±0.0149	0.0152±0^{d}	0.0327±0
β-sitosterol	0.2404±0.1421	0.3651±0^{d}	0.0213±0.010	4.388±0^{cd}	0.0386±0
Retinol	0.0005±0	-	-	-	0.0001±0^{cd}
Retinol ast	0.0003±0	0.0001±0	-	0.0058±0^{d}	-

(T+Lp: Dandelion+*L.plantarum*, T: Dandelion-Control),A+Lp: Asparagus +*L.plantarum*, A: Asparagus-Control), (**cd: <0.0001, d: p<0.001**).

A study has determined that *Asparagus* roots contain β-sitosterol, sitosterol-β-d-glucoside [21]. It has been reported that asparagus is rich in vitamins A, B, C, E and K and has therapeutic and protective properties against many diseases [23].

3.5. Flavonoid contents

It was observed that the levels of rutin, morin, catechin, naringin, naringenin and resveratrol decreased in T+Lp compared to T, the quercetin level did not change, and all parameters decreased in A+Lp extracts compared to A (Figure 2). According to these results, the decrease in flavonoid amounts means that Lp uses and consumes flavonoids in the environment as a nutritional need and maintains its vitality, therefore, it is thought that these substances are nutrients that help Lp to activate. It has been stated that dandelion is used as a traditional medicine due to the presence of phenolic compounds, flavonoids and sugars it contains [24]. Studies have shown that dandelion is rich in sterols, flavonoids and inulin [19], has a strong antioxidant property and is an indispensable nutrient for health, and also contains resveratrol, a phenolic compound that has anti-mutagenic, anti-inflammatory and cancer chemopreventive activity, which is effective in carcinogenesis. [25] It has been emphasized that plant phenols are very important in terms of their antioxidant, antitumoral and antibiotic activities [26]. Flavonoids, a subclass of phenolic compounds, also attract the attention of researchers because they are free radical scavengers, regulate enzyme activities and prevent cell proliferation, and dandelion is used in traditional treatments. In some countries, it is used for liver, spleen and kidney disorders, and in our country, it is used as a bile duct, diuretic and antidiabetic. [27]. Another study has indicated that dandelion leaves are also very important. As a result of these studies, it has been stated that the leaves and roots are used in drug production. Another study has indicated that dandelion contains sterols, flavonoids and inulin [19], has a strong antioxidant property and is an indispensable nutrient for health. In a study, it has stated that dandelion leaves are also very important and their leaves and roots are used in medicine. It is stated that dandelion contains sterols, flavonoids and inulin, has strong antioxidant properties and is an indispensable nutrient for health [19]. It was observed that asparagus preserved under different storage conditions showed physical, chemical, histological and microbiological changes [28], and that there were differences in antioxidant capacities as a result of the analyses performed after the development of *A. officinalis* (asparagus) exposed to 5 different light and air environments [29]. They stated that asparagus is a good source of protein containing all the necessary amino acids [30]. These studies are similar to our studies in terms of chemical content.



T+Lp: Dandelion+*L.plantarum*, T: Dandelion, A+Lp: Asparagus+*L.plantarum*, A: Asparagus.

Figure 2 Flavonoid and resveratrol contents of T and A treated Lp compared to control and comparison (µg/1g)

3.6. Antimicrobial Activity

The antibacterial and antifungal effects of the fatty acid and vitamin extracts of dandelion and asparagus plants used in the study and the antimicrobial activities (mm) of the fatty acid and vitamin extracts of T and A treated with Lp are given in Table 4. According to the results, when the antimicrobial effects of the fatty acid samples extracted from T were examined, it was found that they were effective on the pathogenic yeasts studied (11-17 mm), and this effect slightly decreased in the extract treated with Lp (9-16 mm). When the antimicrobial properties of the vitamin contents were examined, it was found that they were very highly effective on all pathogenic groups (25-35 mm), but this effect slightly decreased in the extracts containing Lp. When the antimicrobial effects of the fatty acid samples of A were examined, it

was determined that they showed the highest effect in Sa (30 mm), the least effect in Ep (8 mm), and generally showed activity on pathogenic yeasts (9-17 mm). It was determined that this activity decreased significantly on the test microorganisms in the Lp groups. When the antimicrobial properties of Lp alone were examined as a control, it was observed that this effect was not very significant. According to the results, the antimicrobial properties of plant vitamin contents were most effective compared to all parameters, and this effect decreased in the Lp groups, and this decrease is thought to be due to the bacteria consuming the components in the environment and using them for their own benefit. When the antimicrobial activity of fatty acids was evaluated, it was determined that they were effective on pathogens, but they did not create an inhibition zone as high as vitamins. It was observed that the antimicrobial activities of vitamins and phytosterols had a significant effect on pathogenic bacteria and yeasts and dermophyte fungi. The fact that vitamins and phytosterols prevent the development of pathogens has shown once again that they are necessary and important for health. It has been reported that fatty acids are the most effective inhibitors of Gr (+) bacteria and yeasts, lauric, myristic, palmitic acids are effective against bacteria, and capric and lauric acids are effective against yeasts [31]. Lauric acid has been found to have a strong bactericidal effect against enterococci Gr (+), and caprylic acid has a strong bactericidal effect against coliforms Gr (-) [32]. Other studies have shown that some food components reduce the effectiveness of antimicrobials naturally present in foods or added to them. Starch reduces the antimicrobial activity of stearic, oleic and linoleic acids, which are effective against *Bacillus cereus* spores and vegetative cells, and palmitic, linoleic and linolenic acids against *Clostridium botulinum* and *C. sporogenes* [33,34]. When comparing skim milk with 12.9% fat milk, bacteriocin and nisin had reduced antilisterial activity in 12.9% fat milk [35]. Another study found that the antimicrobial activity of the antioxidant BHA against several yeasts, molds and bacteria in corn oil broth was significantly reduced [36]. The efficacy of lipophilic antimicrobials such as monolaurin, sorbic acid and certain fatty acids has been found to be reduced in high-fat foods [37-39]. Lauric, oleic, linoleic and linolenic acids at levels ≤150 µg/ml were inhibitory to the growth of *C. botulinum* and *C. sporogenes* spores [33,34]. Caprylic, capric, lauric myristic, oleic and linoleic acids were found to be inhibitory to the growth of *Clostridium botulinum*.

Table 4 Antimicrobial activity of the materials used in the study on pathogenic bacteria (mm.)

Örn	**Sa**	**Bm**	**Kp**	**Ec**	**Cg**	**Ca**	**Ep**	**Tr**
TFAA	27	11	13	-	11	13	17	12
TFAA-Lp	10	8	-	10	16	10	-	9
TVA	35	29	37	35	25	27	25	25
TVA-Lp	10	17	10	12	19	16	12	22
AFAA	30	-	14	8	17	9	13	11
AFAA-Lp	15	-	-	-	25	15	23	8
AVA	25	35	35	37	27	25	27	27
AVA-Lp	-	-	-	8	-	13	-	-
Lp	8	-	-	-	11	-	-	-

TFAA: Antimicrobial activity of dandelion fatty acids, TFAA-LP: Antimicrobial activity of dandelion treated Lp extract fatty acids, TVA: Antimicrobial activity of dandelion vitamin contents, TVA-Lp: Antimicrobial activity of dandelion treated Lp extract vitamins, AFAA: Antimicrobial activity of asparagus fatty acids, AFAA-Lp: Antimicrobial activity of asparagus treated Lp extract fatty acids, AVA: Antimicrobial activity of asparagus vitamin contents, AVA-Lp: Antimicrobial activity of asparagus treated Lp extract vitamins, Lp: Some antimicrobial activity of *L.plantarum*. . (Bm: *B.megaterium*, Sa: *S.aureus*, Ec: *E.coli*, Kp: *K.pneumonia*, Cg: *C. glabrata*, Ca: *C. albicans*, Ep: *Epidermophyton* spp., Tr: *Trichophyton* spp., T: Dandelion, A: Asparagus).

4. Conclusion

As a result, it was determined that the plants used in the study had significant effects on the development of L. plantarum and that this effect produced positive results. This study draws attention to the relationship between probiotic bacteria and plant-based nutrition. The importance of these plants in activating the development of probiotic bacteria and preserving the vitality of this probiotic bacteria, which is necessary for a healthy life, has been highlighted.

Compliance with ethical standards

Acknowledgments

This study was supported by FÜBAP Fırat University Scientific Research Project Coordination (project no. 1861). I would like to thank Prof. Dr. Ökkeş Yılmaz and Prof. Dr. Merih KIVANÇ for their technical and material support during our studies.

Disclosure of conflict of interest

All authors declared no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Lebeer S, Claes IJ, Verhoeven TL, Vanderleyden J, De Keersmaecker SC. Exopolysaccharides of Lactobacillus rhamnosus GG form a protective shield against innate immune factors in the intestine. Microbial biotechnology. 2011; 4 (3): 368-374. doi: 10.1111/j.1751-7915.2010.00199.x

[2] Biçer D, Eminoğlu DE. Probiotics and periodontal health review. Selcuk Dent J. 2022; 9: 706-712. doi: 10.15311/selcukdentj.956715

[3] Kaleli İ. Mechanism of action of probiotics. Journal of the Antibiotic and Chemotherapy Association. 2007; 21(2):238-242. https://ankemdernegi.org.tr/ANKEMJOURNALPDF/ANKEM_21_Ek2_238_242.pdf

[4] İnanç N, Şahin H, Çiçek B. Probiyotik ve prebiyotiklerin sağlık üzerine etkileri. Erciyes medical journal. 2005; 27(3): 122-127. https://jcpres.com/storage/upload/pdfs/EMJ_27_3_122_127.pdf

[5] Copper BO. Overview of prebiotics, probiotics and synbiotics. Nutrition and diet magazine. 2012; 40(2):178-182. https://beslemevediyetdergisi.org/index.php/bdd/article/view/265

[6] Özden A. Friendly bacteria useful for healthy living. Fersa printing ltd. şti. Ankara, Türkiye, 2010; 221.

[7] Santos A, San Mauro M, Diaz DM. Probiotics and their long term influence on the microbial populations of the mouse bowel. Food microbiol 2005; 23:498-503. doi: 10.1016/j.fm.2005.07.004

[8] Güvenç M. Yılmaz Ö, Özsahin AD, Aslan A, Tuzcu M, Kireçci OA. The Growth of Saccharomyces cerevisiae in the different containing grape juices environment affects fatty acid biosynthesis and activities of responsible enzymes. Turk. j. sci. technol. 2010; 5(1):43-51. https://kutuphane.dogus.edu.tr/mvt/pdf.php

[9] Güvenç M, Yılmaz Ö, Tuzcu M, Özşahin AD. Contribution of vitamin C and α-lipoic acid and their combination on the products level of desaturase enzymes in the lung and muscle tissues of poorly controlled experimental diabetic rats. 2009; Res. j. biol. sci. 4(6): 710-715. https://www.researchgate.net/publication/274955723

[10] Williams WB, Cuvelier ME, Berset C. Use of a free radical method to evaluate antioxidant activity. LWT- Food science and technology. 1995; 28(1):25-30. https://doi.org/10.1016/S0023-6438(95)80008-5

[11] Hsu B, Coupar IM, Ng K. Antioxidant activity of hot water extract from the fruit of the doum palm hyphaenethebaica. Food chem. 2006; 98:317-328. http://dx.doi.org/10.1016/j.foodchem.2005.05.077

[12] Yilmaz Ö, Özsahin AD, Bircan B, Erden Y, Karaboga Z., Radical scavenging activity of the Pistacia terebinthus in fenton reagent environment and its protective effects on the unsaturated fatty acids. Asian j. chem. 2010; 22(10): 7949-7958. https://asianpubs.org/index.php/ajchem/article/view/12029/12010

[13] Önganer AN. Phytochemical content and antimicrobial properties of some plants containing inulin and their effects on probiotic bacteria development. Firat university, Institute of Science, doctoral thesis, Elazig, Türkiye (2010)

[14] Munoz AJC, Giusiano G, Guarro J, Quindos G, Guardia C, Valle OD, Rodríguez V, Estivill D, Cardenes CD. Int. j. antimicrob. Agents. 2007; 30(2): 157-161. doi: 10.1016/j.ijantimicag.2007.04.004

[15] Aydin S. Institute of technology. Sikago-USA (1999).

[16] Brown AJ. Atherosclerosis: cell biology and lipoproteins: cholesterol absorption inhibitors: gateway therapy for hypercholesterolaemia. Curr opin lipidol. 2002; 13(6): 701-703. https://journals.lww.com/colipidology/citation/2002/12000/atherosclerosis__cell_biology_and_lipoproteins_.16.aspx

[17] Hu C, Kitts DD. Antioxidant, prooxidant, and cytotoxic activities of solvent-fractionated dandelion (Taraxacum officinale) flower extracts in vitro. J. agric. food chem. 2003; 51 (1), 301–310. doi: 10.1021/jf0258858

[18] Jeon HJ, Kang HJ, Jung HJ, Kang YS, Lim CJ, Kim,YM, Park EH. Anti-inflammatory activity of Taraxacum officinale. Journal of ethnopharmacology. 2008;115 (1), 82-88. doi: 10.1016/j.jep.2007.09.006

[19] Yan Q, Xing Q, Liu Z, Zou Y, Liu X, Xia H. The phytochemical and pharmacological profile of dandelion. Biomedicine and pharmacotherapy. 2024;179: 117334. https://doi.org/10.1016/j.biopha.2024.117334

[20] Nishimura M, Ohkawara T, Katsuyama HK, Sato H, Nishihira J. Improvement of blood pressure, glucose metabolism, and lipid profile by the intake of powdered Asparagus bottom-stems and cladophylls. J. tradit complement med. 2013; 3(4): 250-255. doi: 10.4103/2225-4110.119728

[21] Huang X, Kong L. Steroidal saponins from roots of Aspragus officinlis. Steroids. 2006; 71(2):171-176. doi: 10.1016/j.steroids.2005.09.005

[22] https://www.memorial.com.tr/saglik-rehberi/karahindiba-cayinin-faydalari-nelerdir-blog Last update: 06.11.2024

[23] https://www.acibadem.com.tr/hayat/kuskonmaz/ Last update: 23.12.2022

[24] Martinez M, Poirrier P, Chamy R, Prüfer D, Gronover CS, Jorquera L, Ruiz G, Taraxacum officinale and related species-An ethnopharmacological review and its potential as a commercial medicinal plant.

[25] J ethnopharmacol. 2015;169: 244-262. doi: 10.1016/j.jep.2015.03.067 Rein D, Paglieroni TG, Pearson DA, Wun T, Schmitz HH, Gosselin R, Keen CL. Cocoa and wine poyphenols modulate platelet activation and function. J Nutr. 2000; 130:2120-2126. doi: 10.1093/jn/130.8.2120S

[26] Apak, R.,1, Güçlü, K., Demirata, B., Özyürek, M., Çelik, S.E., Bektaşoğlu, B., Berker, K.I., Özyurt, D., Comparative evaluation of various total antioxidant capacity assays applied to phenolic compounds with the CUPRAC assay. Molecules. 2007; 12(7): 1496-1547. doi: 10.3390/12071496

[27] Sarı A, Özsoy N, Karahüseyin S. Taraxacum farinosum Hausskn. and Bornm. Examination of the plant in terms of antioxidant activity. Journal of advanced research in health sciences. 2020; 3(1):13-19. doi: 10.26650/JARHS2020-670992

[28] Villanueva MJ, Tenorio MD, Sagardoy M, Redondo A, Saco MD. Physical, chemical, histological and microbiological changes in fresh green asparagus (Asparagus officinalis, L.) stored in modified atmosphere packaging. Food Chemistry, 2005; 91 (4): 609-619. https://doi.org/10.1016/j.foodchem.2004.06.030

[29] Nindo CI, Sun T, Wang SW, Tang J, Powers JR. Evaluation of drying technologies for retention of physical quality and antioxidants in asparagus (Asparagus officinalis, L.). LWT - Food science and technology. 2003;36(5): 507-516. doi:10.1016/S0023-6438(03)00046-X

[30] Lopez G, Rosa G, Rincon F, Ortuno J, Periago MJ, Martínez MC. Amino acids and in vitro protein digestibility changes in green 146 asparagus (Asparagus officinalis, L.) during growth and processing. Food research international. 1996; 29 (7): 617-625. doi: 10.1016/s0963-9969(96)00072-5

[31] Ova G. 2001. Protectors. Food additives. Ege University Faculty of Engineering p. 128.

[32] Sun CQ, Connor CJO, Roberton AM. The antimicrobial properties of milkfat after partial hydrolysis by calf pregastric lipase. Chem. bio. int. 2002;140(2) 185-198. doi: 10.1016/s0009-2797(02)00016-9

[33] Ababouch L, Chaibi A, Busta FF. Inhibition of bacterial spore growth by fatty acids and their sodium salts. J. food prot. 1992; 55(12): 980–984 doi: 10.4315/0362-028X-55.12.980.

[34] Ababouch L. Bouqartacha F, Busta FF. Inhibition of Bacillus cereus spores and vegetative cells by fatty acids and glyceryl monododecanoate. Food microbiol. 1994; 11: 327–336.

[35] Jung DS, Bodyfelt FW, Dawschel MA. Influence of fat and emulsifiers on the efficacy of nisin inhibiting Listeria monocytogenes in fluid milk. J. dairy sci. 1992; 75(2):387–393. doi: 10.3168/jds.S0022-0302(92)77773-X.

[36] Munoz ER, Davidson PM. Effect of corn oil and casein on the antimicrobial activity of phenolic antioxidants. J. food sci. 1983; 48(4): 1284-1288. https://doi.org/10.1111/j.1365-2621.1983.tb09212.x

[37] McLay JC, Kennedy MJ, Orourke AL, Elliot RM, Simmonds RS. Inhibition of bacterial foodborne pathogens by the lactoperoxidase system in combination with monolaurin. Int. j. food microbiol. 2002; 73(1) 1-9. doi: 10.1016/s0168-1605(01)00698-5.

[38] Sofos JN, Busta FF. Antimicrobial activity of sorbate. J. food prot. 1981; 44(8): 614-622. doi: 10.4315/0362-028X-44.8.614.

[39] Wang LL, Yang B, Parkin KL, Johnson EA. Inhibition of Listeria monocytogenes by monoacylglycerols synthesized from coconut oil and milkfat by lipase-catalyzed glycerolysis. J. agric. food chem. 1993; 41(6):1000-1005. doi: 10.1021/jf00030a033