



Biochemical compositions and antibacterial activities of *Lantana camara* plants with yellow, lavender, red and white flowers

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Abstract

Here we report the biochemical composition and antibacterial activities of the leaves and flowers of four *Lantana camara* (Verbanaceae) plants with yellow, lavender, red, and white flowers. Three out of the four plants showed almost similar carbohydrates and lipid compositions. The levels of carbohydrates (mg/g dry weight) in the flowers were comparatively higher than in the leaves and the lipids content was relatively higher in the leaves except *L. camara* lavender and white. In lavender *L. camara* the amount of the total carbohydrates was very low. Proteins extracted from the leaves and flowers were subjected to electrophoresis. Electrophoresis of leaf proteins revealed similarity among *L. camara* yellow, red, and white flowers while that of flowers proteins showed similarity between *L. camara* yellow, lavender, red, and white. Extracts of leaves and flowers obtained with ethyl acetate were studied for antibacterial activities. Leaf and flower ethyl acetate extracts exhibited considerable antibacterial activities against the bacteria used where the value of zone of inhibition ranged from 10-21 and 9-15 mm, respectively. For flower and leaf ethyl acetate extracts, the zone of inhibition (mm) measured ranged from 10-21 and 9-15 mm, respectively. Thus, the study of the biochemical parameters viz., lipids, carbohydrates and proteins has revealed similarity among the four different *L. camara*. However, antibacterial activities vary from one *L. camara* to the other and also according to the type of tissue used.

Keywords: Antibacterial activity, *Lantana camara*, zone of inhibition.

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INTRODUCTION

Lantana camara L. (Verbanaceae), commonly known as wild or red sage is the most widespread species of this genus and regarded both as a notorious weed and a popular ornamental garden plant (Sharma et al. 1987). However, it is listed as one of the important medicinal plants of the world (Ross 1999). *L. camara* contains lantadenes, the pentacyclic triterpenes which is reported to possess a number of useful biological activities. Several previous reports have described antifungal, (Tripathi and Shukla 2002, Kumar et al. 2006), anti proliferative (Saxena et al. 1992, Nagao et al. 2002), and antimicrobial activities of *L. camara* (Saxena et al. 1992, Juliani et al. 2002, Kasali et al. 2002, Rajakaruna et al. 2002) including

termicidal activity reported recently by Verma and Verma (2006). Moreover, the hydro-alcoholic extracts of the leaves have shown an effect on fertility, general reproductive performance, and teratology in rats (Mello et al. 2005).

L. camara whole plant and plant parts viz., leaves, flowers, and essential oils have been thoroughly studied for their chemical compositions, previously and currently (Saleh 1974, Hart et al. 1976, Sharma and Sharma 1989, Siddiqui et al. 1995, Ghisalberti 2000). All these studies have revealed the presence of terpenoids, steroids, and alkaloids as major chemical constituents in *L. camara* (Saleh

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1974, Hart et al. 1976, Sharma and Sharma 1989 Siddiqui et al. 1995,). However, sesquiterpenes with mainly β -caryophyllene, zingiberene, δ -humulene, arcurcumene, gemacrene-D and bisabolene were reported as major leaf and flower essential oil constituents (Singh et al. 1991, 2002, Nagassoum et al. 1999, Khan et al. 2002, Andersson and Dobson 2003). Chemical composition of the whole plant and plant parts and essential oils are reported to be influenced by genetic, geographical, and seasonal factors as well as the developmental stages of the concerned plant, its parts/tissues. Previously, Randrianalijaona et al. (2005) have reported the seasonal changes in the chemical composition of essential oils in more than seventy *L. camara* from different parts of the world. Very recently, we reported ontogenic variation in secondary metabolites such as phenolics, anthocyanins, and proanthocyanidins in *L. camara* (Bhakta and Ganjewala 2009). However, in *L. camara* very few studies have so far been focused on the influence of seasonal, genetic, ontogenic, and developmental factors of the chemical composition. Hence, more intensified research work needs to be carried out to understand the chemical variation in relation to the genotype, season, environmental, geographical or other factors. The present study is aimed to study the biochemical composition of the four different types of *L. camara* plants bearing yellow, red, lavender, and white flowers. In addition, their antibacterial activities have also been studied. The study of their biochemical composition such as lipids, proteins, and carbohydrates suggested a high similarity among them.

MATERIAL AND METHODS

Plant material

Leaves and flowers of four *Lantana camara* plants were collected from the campus of the Vellore Institute of Technology University, Vellore, Tamil Nadu, India during the period from January to April, 2007.

Methods

Determination of dry weight

For the determination of dry weight, a known number (25) of the leaves and flowers were weighed immediately after harvest and then were oven dried at temperatures below

< 50°C until a constant weight for dry weight was achieved.

Determination of proteins, carbohydrates and lipids

Proteins were extracted using the modified procedure of Ganjewala and Luthra (2007) and estimated using the Bradford method (1976). The total sugars and reducing sugars were determined according to Yemm and Willis (1954) and Nelson (1944), respectively. Total non-reducing sugar was calculated as the difference in the concentration of total sugars and total reducing sugars. Sucrose and fructose were determined afterwards in the same sample using the Handel method (1968). Sucrosyl fructose was determined by dividing the concentration of sucrose by 1.9 and the non-sucrosyl fructose from the difference in values of total and sucrosyl fructose. Starch was estimated using the Clegg method (1965). Total lipids were extracted using the Folch's method (1957). Phospholipids and glycolipids were estimated based on previously published procedures (Roughan and Batt 1969, Lowry and Tinsley 1976).

Thinlayer chromatography of the lipid extracts

Lipid extracts were subjected to thin layer chromatography for the separation of polar and neutral lipids (Hansen and Rossi 1990). Two solvent systems used for neutral lipids were toluene- hexane-formic acid (140:60:1, v/v) and hexane- diethyl ether- formic acid (60:40:1, v/v) and for separation of polar lipids solvent system containing chloroform - methanol - toluene (28%) - ammonium hydroxide (65:30:10:6, v/v) and chloroform-methanol- toluene- acetone- acetic acid- water (70:30:10:5:4:1 v/v). The plates were sprayed with a 0.05% (w/v) solution of 8-anilino-4-naphthalene-sulphonic acid prepared in methanol and viewed under a UV light.

Protein electrophoresis

A native polyacrylamide gel electrophoresis (PAGE) was carried out according to Laemmli (1970). The native PAGE for leaf and flower proteins was conducted on a 12.5% separating and 4% stacking gel. A Tris base and glycine solution (pH 8.0) was used as running buffer. An equal amount of proteins were mixed properly with 10% sucrose and a 0.1% (w/v) solution of bromophenol blue was added to the gel slab wells. The

electrophoresis was carried out at room temperature for three hours at a constant rate of 50 volts. After electrophoresis the gels were stained by incubating overnight in a solution containing coomassie brilliant blue, methanol and acetic acid in distilled water. After incubation the gels were de-stained with a de-staining solution (methanol-acetic acid-distilled water) and photographed with a digital camera (Nikon).

Phytochemical analysis

Specific qualitative tests were performed for detection of common secondary metabolites in leaf and flower extracts. Alkaloids were identified by Mayer's test while the Libermann test was performed for phytosterols. The presence of sterols was confirmed by the addition of 2 mL of acetic anhydride to 0.5 g of dried ethyl acetate extract with 2 mL of concentrated sulphuric acid. For identification of phenolics, one ml of neutral ferric chloride was added to one ml of the extract. To reveal the presence of tannins 0.5 g of the dried powder of the leaves and flowers were boiled with 5 mL of water in a test tube and then filtered. To the filtrate ferric chloride was added and kept undisturbed for the observation.

Antibacterial assay

Preparation of leaf and flower extracts

Fresh flowers and leaves were collected, washed and weighed (4 g each). The materials were then macerated in 10 mL of ethyl acetate, acetone, and chloroform separately and then kept for 6 h at room temperature. The mixtures were then filtered through sterile Whatmann filter paper No.1. The filtrates obtained were then centrifuged at 5000 rpm for 5 min. The supernatants were collected in a beaker and the solvents were allowed evaporate and the dry extracts were stored at 4°C. The extracts were dissolved in 1-3 mL (w/v) of dimethyl sulfoxide (DMSO) at the time of the antibacterial assays (Priya and Ganjewala 2007).

Preparation of microorganisms

The test organisms used in this study were *Escherichia coli* (MTCC901), *Pseudomonas aeruginosa* (MTCC429), *Bacillus subtilis* (1429) and *Staphylococcus aureus* (MTCC96). The strains were maintained on nutrient agar slants at 4°C. A loopful of each bacterial strain was added to a 50 mL sterile

nutrient broth in a 100 mL conical flask. The flasks were then incubated on a rotary shaker for 24 h to activate the strain.

Agar well diffusion method

The antibacterial activities of the extracts of the leaves and flowers of *L. camara* plants obtained with three different solvents, ethyl acetate, acetone and chloroform were evaluated by the agar well diffusion method (Deena and Thoppil 2000). The strains that had been incubated for 24 h were used for the assay. A sterile cotton swab was dipped into the bacterial suspension and then was evenly streaked over the entire surface of a sterile Mueller Hinton agar plate to obtain a uniform inoculum. Wells were punched on the seeded plates using a sterile borer (8 mm) and the plates were allowed to dry for 5 min. Ethyl acetate, chloroform and acetone extracts (100, 150 and 200 μ L) were dispensed into each well using a sterile micropipette. Dimethyl sulfoxide was used as a negative control and streptomycin (10 μ L) was used as a positive control. The plates were incubated overnight at 37°C and the antibacterial activity was determined by measuring the diameter of zone of inhibition (mm).

RESULTS

Biochemical compositions of *Lantana camara* leaves and flowers

The biochemical compositions of *L. camara* leaves and flowers are presented in Table 1. The levels of carbohydrates for example reducing and non reducing sugars and others in the flowers of four *L. camara* plants were comparatively higher than those in the corresponding leaves. In all the *L. camara* flowers studied here contained three fold total sugars (mg/g dry weight) than the leaves except in *L. camara* lavender. Similarly, the amount of fructose and sucrose (mg/g dry weight) was significantly higher, 5-10 fold, in the flowers than the leaves. Sucrosyl and non-sucrosyl fructose as well as starch was also present in abundant amounts in the flowers compared to the leaves.

Like carbohydrates, the lipid content (phospholipid and glycolipid) too varies with the type of *L. camara* as well tissue type (Table 1). The results showed that in all the *L. camara* studied, the leaves contained significantly higher amounts of phospholipid

Table 1. The biochemical compositions of the leaves and flowers of *Lantana camara* with yellow, lavender, red, and white flowers.

Biochemical trait (mg/g tissue dry wt.)	<i>Lantana camara</i>							
	Yellow		Lavender		Red		White	
	Leaves	Flowers	Leaves	Flowers	Leaves	Flowers	Leaves	Flowers
Total sugar	1.30	3.90	1.00	1.10	1.20	4.60	1.10	3.60
Reducing sugar	0.64	2.50	0.05	2.00	0.35	1.50	0.05	1.50
Non-reducing sugar	0.66	1.40	0.95	0.90	0.85	3.10	1.05	2.10
Fructose	0.31	3.00	0.28	1.50	0.24	2.20	0.28	1.30
Sucrose	1.57	6.60	0.81	5.00	0.93	4.10	0.99	4.90
Sucrosyl fructose	0.82	3.47	0.43	2.60	0.48	2.15	0.52	2.50
Non-Sucrosyl fructose	1.26	3.13	0.39	2.40	0.45	1.90	0.47	2.30
Starch	0.04	2.70	0.05	2.22	0.38	1.66	0.05	1.60
Phospholipids	4.25	3.25	9.75	4.00	3.25	2.50	3.75	2.50
Glycolipids	1.28	0.52	0.40	0.40	1.00	0.13	0.28	0.40

(mg/g dry weight) than those of the flowers. However, both leaves and flowers contained very low amounts of glycolipids. The maximum phospholipids content was recorded in the *L. camara* lavender leaf whereas the maximum glycolipids contents were recorded in the yellow and red *L. camara* flowers. Lipid extracts were also subjected to thin layer chromatography (Figs. 1 and 2). The results revealed that the flower neutral lipid profiles were identical to the leaf neutral lipid profiles but the flower polar lipid profiles did not match with those of the leaves in all four *L. camara*.

Protein electrophoresis

An electrophoretogram of leaf proteins showed that two proteins, 35 and 25 kDa, were present and common in all the *L. camara* types (Fig. 3). In the flower protein extracts a ~30 kDa protein was found to be common (Fig. 3). However, a low molecular weight protein (10 kDa) was present in only two *L. camara* yellow and lavender. *L. camara* lavender exhibited characteristic leaf protein profiles that could be distinguished from others by the presence of two proteins of a molecular weight 14.4 and 7.7 kDa. The proteins, 14.4 and 7.7 kDa, were exclusively present in *L. camara* lavender leaf proteins extracts. Comparative study of leaf protein profiles revealed similarities among the three *L. camara* types, red, yellow, and white. Similarly, a comparative study of flower protein profiles revealed similarities between *L. camara* yellow and lavender and *L. camara* red and white.

Phytochemical analysis

Qualitative tests have detected around 7-8 common secondary metabolites in the leaf and flower extracts such as alkaloids, phenolics, and terpenoids and other minor compounds phytosterols, saponins, tannins, phycobatanin and steroids (Table 2). Steroids, however, could not be detected in *L.*

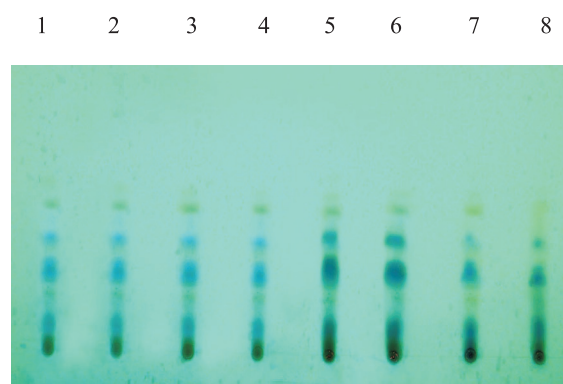


Fig. 1. A thin layer chromatogram of the neutral lipids of the four *L. camara* leaf and flower extracts. Lane 1-8 depicts 1 = yellow flower, 2 = lavender flower, 3 = red flower, 4 = white flower, 5 = yellow leaf, 6 = lavender leaf, 7 = red leaf and 8 = white leaf.

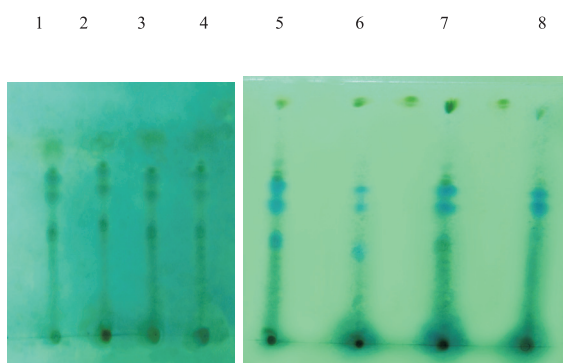


Fig. 2. A thin layer chromatogram of the polar lipids of the four *L. camara* leaf and flower extracts. Lane 1-8 depicts 1 = yellow flower, 2 = lavender flower, 3 = red flower, 4 = white flower, 5 = yellow leaf, 6 = lavender leaf, 7 = red leaf and 8 = white leaf.

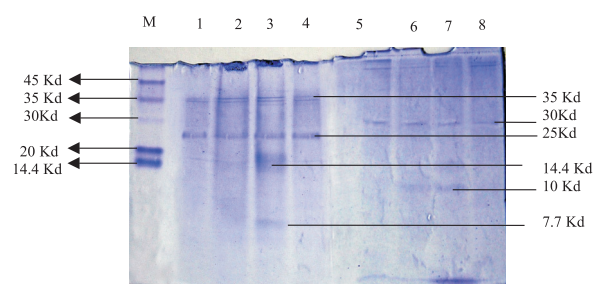


Fig. 3. The electrophoretogram depicting the protein profiles of the four *L. camara* plants. Lane 1 and 5 = leaf and flower proteins of the red *L. camara*, lane 2 and 6 = leaf and flower proteins of the yellow *L. camara*, lane 3 and 7 = leaf and flower proteins of the lavender *L. camara*, lane 4 and 8 = leaf and flower proteins of the white *L. camara*. M = Molecular mass markers.

Table 2. The phytochemical compositions of the leaves and flowers of *L. camara* with yellow, lavender, red, and white flowers.

Secondary metabolite	<i>Lantana camara</i>							
	Yellow		Lavender		Red		White	
	Leaves	Flowers	Leaves	Flowers	Leaves	Flowers	Leaves	Flowers
Alkaloids	+	+	+	+	+	+	+	+
Phenolics	+	+	+	+	+	+	+	+
Terpenoids	+	+	+	+	+	+	+	+
Phytosterols	+	+	+	+	+	+	+	+
Steroids	-	-	-	-	+	+	+	-
Tannins	+	+	+	+	+	+	+	+
Saponins	+	+	+	+	+	+	+	+

+ = Present; - = Absent

camara yellow and lavender leaf extracts.

Antibacterial activities of *L. camara* leaves and flowers

The antibacterial activities of *L. camara* leaf and flower extracts are presented in Table 3 a and b. The table shows that *L. camara* flower extracts possess strong antibacterial activities more than the corresponding leaf extracts. Extracts were prepared in acetone, chloroform, and ethyl acetate, however, only ethyl acetate extracts was found to be the most effective against all of the bacteria except *S. aureus*. Acetone and chloroform extracts did not show any significant inhibitory effects against the bacteria used. All four types of *L. camara* flower extracts displayed almost similar antibacterial activities with zone of inhibition value ranging from 10-21 mm (Table 3a). *L. camara* yellow and white flowers extracts showed the highest inhibitory effects against *B. subtilis* with a measured value of zone of inhibition of 21 and 20 mm, respectively. Leaf extracts compared to the flower extracts, displayed less inhibitory effects against all the bacteria tested with a relatively smaller zone of inhibition area ranging from 9-15 mm (Table 3b). *E. coli* (>300 x 10⁶-10⁸ CFU/mL) was found to be the most sensitive bacteria to all *L. camara* flowers and leaf extracts. *P. aeruginosa* and *B. subtilis* (>200 x 10⁶-10⁸ CFU/mL) was also found to be highly susceptible to all *L. camara* flower and leaf extracts. Antibiotic streptomycin was used as a control. While *E. coli* was highly sensitive to streptomycin *B. subtilis*, and *P. aeruginosa* were found to be resistant to streptomycin.

DISCUSSION

The biochemical composition of plants is the most common parameter used for the characterization of plants. Hence we have studied the biochemical composition of four *L.*

Table 3a. The antibacterial activities of the flower extracts of *L. camara* with yellow, lavender, red, and white flowers.

<i>L. camara</i>	Extract	Bacteria	Zone of growth inhibition (mm)				
			<i>E. coli</i>	<i>P. aeruginosa</i>	<i>B. subtilis</i>	<i>S. aureus</i>	
			Yellow	Ethyl acetate	17	16	21
	Chloroform	12	15	11	R		
	Acetone	14	12	12	R		
	Streptomycin	12-22	R	R	14-22		
Lavender	Ethyl acetate	18	15	15	R		
	Chloroform	11	14	10	R		
	Acetone	17	14	12	R		
	Streptomycin	12-22	R	R	14-22		
Red	Ethyl acetate	17	16	15	R		
	Chloroform	12	15	16	R		
	Acetone	11	13	13	R		
	Streptomycin	12-22	R	R	14-22		
White	Ethyl acetate	18	15	20	R		
	Chloroform	13	15	10	R		
	Acetone	14	13	12	R		
	Streptomycin	12-22	R	R	14-22		

Table 3b. The antibacterial activities of the leaf extracts of *L. camara* with yellow, lavender, red, and white flowers.

<i>L. camara</i>	Extract	Bacteria	Zone of growth inhibition (mm)				
			<i>E. coli</i>	<i>P. aeruginosa</i>	<i>B. subtilis</i>	<i>S. aureus</i>	
			Yellow	Ethyl acetate	13	11	14
	Chloroform	10	14	09	R		
	Acetone	15	11	09	R		
	Streptomycin	12-22	R	R	14-22		
Lavender	Ethyl acetate	14	12	14	R		
	Chloroform	09	09	10	R		
	Acetone	09	10	11	R		
	Streptomycin	12-22	R	R	14-22		
Red	Ethyl acetate	09	13	10	R		
	Chloroform	10	09	09	R		
	Acetone	09	10	10	R		
	Streptomycin	12-22	R	R	14-22		
White	Ethyl acetate	14	10	14	R		
	Chloroform	10	14	09	R		
	Acetone	14	12	10	R		
	Streptomycin	12-22	R	R	14-22		

R = Resistant

camara types flowers and leaves. However, the biochemical as well as the chemical compositions of the concerned plants parts or tissues is often influenced by different origins, environmental, and seasonal factors. Previously, Randrianalijaona et al. (2005) has reported seasonal changes in the chemical composition of essential oils in more than seventy *L. camara* from different parts of the world. Very recently, Bhakta and Ganjewala (2009) reported the effects of leaf position on the level of secondary metabolites in *L. camara*. These studies have clearly suggested the geographical, developmental stage of the plant, and ontogeny influence the essential oil and or biochemical compositions in *L. camara*. The slight variation in biochemical compositions of the *L. camara* studied here, however, could be well attributed to genetic rather than environmental and seasonal factors. However, studies of genetic, environmental, seasonal, and developmental variation in the chemical composition of the plant and essential oils in *L. camara* are very limited. In fact, no report is available regarding

the developmental variation in the chemical composition in *L. camara*. Electrophoretic studies of the *L. camara* leaf proteins revealed similarities among three *L. camara* with red, yellow and white flowers. On the other hand, electrophoretic studies of flower proteins showed similarities between *L. camara* yellow and lavender and *L. camara* red and white. Thus, the overall results of leaf and flower protein profiles have indicated genetic similarities among all the four *L. camara* types. However, the protein profiles exclusively can not imply to discern genetic relationship as these protein profiles are often influenced by the developmental stages of the concerned plant parts, organs and tissues. In *L. camara* leaf and flower tissue specific variation in the protein profiles are clearly evident. Currently, in our laboratory *L. camara* seed proteins are being studied by electrophoretic procedure for better resolution of the genetic relation among different *Lantana* species. Seed protein profiles have been considered excellent and a stable biochemical marker for the identification of cultivars and to discern the genetic relationship in plants. The phytochemical compositions of the four *L. camara* presented in Table 2 are very typical of many *Lantana* species reported previously (Hart et al. 1976, Sharma and Sharma 1989, Siddiqui et al. 1995, Verma and Verma 2006).

L. camara has been studied extensively for their antibacterial properties (Siddiqui et al. 1995, Deena and Thoppil 2000, Mello et al. 2005, Verma and Verma 2006). *L. camara* possess many important biological activities viz., antipyretic, antimicrobial, antimutagenic, antimicrobial, fungicidal, insecticidal, nematocidal, and others (Siddiqui et al. 1995, Deena and Thoppil 2000, Mello et al. 2005, Verma and Verma 2006). Lantadenes present in all *L. camara* is believed to be responsible for almost all the biological activities (Barre et al. 1997). In addition, other secondary metabolites such as alkaloids, terpenoids, and phenolics could be held partially responsible for some of these biological activities (Barre et al. 1997). However, constituents like 1,8-cineole, sabinene, and caryophyllene and other minor constituents viz., E-nerolidol, bicyclogermacrene, and pinene identified in leaf essential oils were also found to be responsible for the biological activities of

essential oils (Chowdhury et al. 2007, Sonibare and Effiong 2008). Therefore, antibacterial activities of *L. camara* leaf and flower extracts reported here might be due to the presence of some of these chemical constituents particularly lantadenes and theveside in the extracts. Bhakta and Ganjewala (2009) have recently confirmed the presence of phenolics, anthocyanins and proanthocyanidins in *L. camara* leaves which could also be responsible for the antibacterial properties of the *L. camara* reported here. Though, the mechanism of the action of these chemical constituents is not yet fully known it is clear that the effectiveness of the extracts largely depends on the type of solvent used. Perhaps it is one of the reasons behind differences in the antibacterial activities of the plants. Moreover, the effectiveness of the extracts varies with its concentration and the kind of bacteria used in the study. These differences in the susceptibility of the test organisms to the different extracts might be due to the variation in the rate at which active ingredients penetrate their cell wall and cell membrane structures (Nikaido and Vaara 1985, Priya and Ganjewala 2007). Thus, *S. aureus* was found to be resistant to all the extracts, which is most probably due to its outer membrane. Nevertheless, it is the ability of the active principle of the extracts that disrupt the permeability barrier of cell membrane structures and thus inhibit the bacterial growth (Nikaido and Vaara 1985, Priya and Ganjewala 2007). In conclusion, the four *L. camara* plants with different flower colours studied here have displayed variable antibacterial activities most probably due to the differences in the biochemical and phytochemical compositions of the concerned plant materials (leaves and flowers) used.

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Sari, Eflatun, Kırmızı ve Beyaz Çiçekli *Lantana camara* Bitkilerinin Biyokimyasal Kompozisyonu ve Antibakteriyel Özellikleri

Özet

Bu çalışmamızda; sarı, eflatun, kırmızı ve beyaz çiçekli dört *Lantana camara* (Verbanaceae) bitkisinin yaprak ve çiçeklerinin biyokimyasal kompozisyonu ve antibakteriyel özellikleri araştırılmıştır. Bitkilerin üç tanesi benzer karbonhidrat ve yağ kompozisyonları sergilediler. Çiçeklerdeki karbonhidrat oranları (mg/g kuru ağırlık) yapraklarına kıyasla daha yüksekti ve yağ içerikleri, eflatun ve beyaz *L. camara* hariç, yapraklarda nispeten daha yüksekti. Eflatun *L. camara*'da toplam karbonhidrat oranı çok düşüktü. Yaprak ve çiçeklerden elde edilen proteinler elektroforeze tabi tutuldu. Yaprak proteinlerinin elektroforezi, *L. camara* sarı, kırmızı ve beyaz çiçekler arasında benzerlikler gösterirken, çiçek proteinlerinin elektroforezi, *L. camara* sarı, eflatun, kırmızı ve beyaz çiçekler arasında benzerlikler sergiledi. Etil asetatla elde edilen yaprak ve çiçek özütlerinin antibakteriyel aktiviteleri araştırıldı. Etil asetat özütleri, kullanılan bakterilere karşı önemli bir oranda antibakteriyel aktivite gösterdi. inhibisyon bölgesi değeri, sırasıyla, 10-21 ve 9-15 mm arasında değişti. Çiçek ve yaprak etil asetat özütlerinde ölçülen inhibisyon bölgesi (mm), sırasıyla, 10-21 ve 9-15 mm arasında değişiklik gösterdi. Biyokimyasal parametrelerin, yani yağlar, karbonhidratlar ve proteinlerin incelenmesi dört çeşit *L. camara* arasında benzerlikler ortaya çıkardı. Ancak, antibakteriyel aktiviteler, bir *L. camara*'dan diğerine ve ayrıca kullanılan doku tipine göre farklılıklar sergiledi.

Anahtar Kelimeler: Antibakteriyel aktivite, inhibisyon bölgesi, *Lantana camara*.