ISSN 1996-3351

Asian Journal of Biological Sciences

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OPEN ACCESS Asian Journal of Biological Sciences

ISSN 1996-3351
DOI: 10.3923/ajbs.2020.361.369

Research Article
Application *of Lantana camara* Flower Extract as a Natural Coloring Agent with Preservative Action

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Abstract

Background and Objective: *Lantana camara* is a weed widely present in different parts of the world and the leaves of the plant is found to be rich in essential oils and found to possess wide variety of pharmacological activities. Scanty studies are available about the flowers of this plant hence; the objective of this study was to evaluate the phenolic content, antioxidant activity, antimicrobial activity and its application as a natural food preservative and natural colorant. **Materials and Methods:** Fresh flowers were collected and extracted by sonication using hydroalcohol and used for the determination of Total Phenolic Content (TPC), Total Flavonoid Content (TFC), Total Tannin Content (TTC) as well as antioxidant activity using DPPH and ABTS radical scavenging activity, reducing capacity by total antioxidant (TAO) and Ferric Reducing Antioxidant Potency (FRAP). Antimicrobial activity of the *Lantana camara* Flower Extract (LCFE) was determined by broth dilution method and its preservative efficacy was studied against two commonly found food pathogens. **Results:** The present study revealed the presence of considerable amount of phenolic content with significant antioxidant activity in terms of DPPH and ABTS radical scavenging capacity and reducing ability. In addition to the antioxidant activity it was also found to possess moderate antimicrobial action. Incorporation of the LCFE in different concentration in the sugar juice imparted reddish brown color with preservative action of juice till 28th day at room temperature. **Conclusion:** The phenolic component enriched LCFE with significant antioxidant and moderate antimicrobial potency can be employed as a natural preservative with coloring properties to overcome the complications associated with synthetic colorants and preservatives.

Key words: Food additive, phytopigments, natural preservative, phytopharmaceuticals, food additives

Citation: Annegowda Hardur Venkatappa, Tripathy Amrutanand, S. Pulak Majumdar and M. Harish, 2020. Application *of Lantana camara* flower extract as a natural coloring agent with preservative action. Asian J. Biol. Sci., 13: 361-369.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Coloring agents are the food additives and pharmaceutical excipients employed to impart aesthetic appearance to either food material, beverages and pharmaceutical dosage forms so as to make them look appealing, to enhance the overall product elegance and to improve the patient acceptability[1,2]. In addition to this, colorants also ensure the product freshness and quality[3]. Globally, there is a ten-fold increase in the demand for the food colorants from the year 2000 to the year 2015 and the trade related to it touched around 1 billion US dollar[4]. These coloring agents are obtained either through chemical synthesis or from natural origin. Synthetic colorants includes sunset yellow, tartrazine, amaranth, quinoline yellow, erythrosine, allura red, carmoisine, brilliant blue and indigo carmine, etc and are often associated with hypersensitivity, reproductive toxicity, genotoxicity, mutagenesity, carcinogenicity, gastrointestinal intolerance like abdominal pain, vomiting, indigestion, organ toxicity, urticaria, rhinitis and eczema[5,6]. Moreover, continuous use of synthetic colorants in children leads to attention deficit hyperactivity disorder represented by frustration, inattention and impulsivity[7]. In order to overcome the adverse effects associated with synthetic colorant, global interest in the coloring agents derived from natural source has increased rapidly. Very few natural colorants are derived from plants includes madder plant, beetroot, cranberry, safflower (red color), saffron flower stigma, bixin (orange color), camomile, curcumin (yellow color) ragweed, buckthorn berries (green), spirulina (blue color), lycopene and carminic acid (orange red)[6,8-11].

Food spoilage and food poisoning caused either by microbes or by the oxidation processes are the main concerns in food and pharmaceutical industries. Preservatives are generally added into the formulations to prevent the growth of food borne pathogens leading to the increase in the shelf life of the formulation and protect them from the contamination by microorganisms[12,13]. To overcome these issues synthetic preservatives like butylated hydroxytoluene, butylated hydroxyanisole and sodium benzoate are employed. These synthetic antioxidants are associated with carcinogenesis in living organisms[14,15]. The adverse effects of synthetic antioxidants are addressed by discovering and employing a potentially effective, safer and natural preservative. Various plant extracts enriched with phenolic content are found to be potent antimicrobials with preservative action[16,17]. Hence, either the plant extracts or the isolated compounds are emerged as an alternative to synthetic antioxidants as well as colorants.

Lantana camara L. is a weed and commonly known with the name wild sage or red sage. It is a native of tropical and sub-tropical regions of America, Asia and Africa. This plant is a woody plant having stems and branches with spines and bears flowers of red, pink, white, violet and yellow color. It is considered as one of the ten noxious weeds of the world and grown in some part of the world as an ornamental plant[18].

Traditionally, the tea prepared from the leaves and flowers of this plant is used to treat fever, influenza, stomachache, cold, rheumatism and asthma[19,20]. Peoples of Asian continent use juice of the leaves to treat cuts, ulcer and as a vermifuge. Decoction of the leaves externally applied to treat leprosy and scabies. Various bioactives like steroids, lancamarone isolated from the leaves of the plant exhibited cardiotonic activity and the alkaloids like lantamine isolated from the stem bark and root revealed the antipyretic and antispasmodic activities[18,21].

Various mono and sesquiterpene essential oil like curcumene, bisabolol, nuciferol, safrole, humulene, caryophyllene, 1,8 cineole, citral, alpha-pinene and davanone were obtained from the hydrodistillation of leaves and flowers of this plant. It also contains the triterpene lantadene A and B as well as a flavonoid icterogenin, hispidulin and trimethoxyquercetin[22-25]. Leaf extract of this plant also exhibited cytotoxic, antifilarial, antimicrobial and antioxidant activities[26]. Various glycosides like verbascoside, isoverbascoside, martynoside and isonuomioside, etc. were isolated from this plant[27].

Pentacyclic triterpenes possess antimicrobial activity against *S. aureus* and *S. typhi*[28]. The essential oils and aqueous extracts of the leaves of the plant have shown good antimicrobial activity against *E. coli, S. aureus, B. cereus, M. luteus* and *P. aeruginosa*[25].

The primary objective of the present study was to evaluate the phenolic content, antioxidant and antimicrobial activities of the *Lantana camara* flower extract. Secondarily to study the suitability of the flower extract as a natural colorant and preservative by incorporating it in the juice preparation maintained at room temperature.

MATERIALS AND METHODS

Chemicals: Nutrient broth, , sodium nitrite, sodium carbonate, ferric chloride, chloramphenicol and vanillin were procured from E-Merck, India, whereas BHT, TPTZ, ABTS, DPPH, potassium persulphate, sodium acetate, p-INT catechin and gallic acid were purchased from Sigma-Aldrich. All the solvents used were of analytical grade and purchased from E-Merck, India.

Plant material: *Lantana camara* fresh flowers were collected from the fields of Mandya district. Collected flowers were washed with running water to remove adhering dirt and immediately used for extraction. The process of plant collection, drying, extraction and the evaluation was carried during June-December 2019.

Extraction of plant sample: The flower material (100 g×2) was cut into small pieces using scissor and poured into a conical flask covered with aluminium foil followed by sonication method of extraction using hydroalcohol as an extracting solvent (2 L) for a period of 1 h (15 min×4 times). Precaution was taken to maintain the temperature of the sonicator at room temperature by recirculation of fresh water. The so obtained liquid extract was later filtered through whatman filter paper followed concentration by Buchi rotary evaporator. The extract was preserved in an air tight container in the refrigerator until further use.

Determination of Total Phenolic Content (TPC): The total phenolic content present in LCFE was determined by the colorimetric method described by Singleton and Rossi[29]. In this method, 2 mL of Folin-Ciocalteu (FC) reagent (10 times pre-diluted with distilled water) was mixed with a known concentration of sample in methanol (400 µL), after 5 min 1.6 mL of sodium carbonate solution (7.5% w/v) was added. The resultant solution was incubated for 1 h in dark at room temperature followed by measuring the absorbance at 765 nm using a UV-visible spectrophotometer. Absorbance of the entire sample and standard were measured against the blank. Blank was prepared without the sample but with 400 µL of methanol. Gallic acid standard in various concentrations (10-100 µg mL^{-1}) was used to construct a calibration curve and the results of total phenolic content was expressed as milligram equivalent of commonly occurring phenol, gallic acid equivalents (mg GAE)/g of dry extract. All the measurements were done in triplicates.

Determination of Total Flavonoid Content (TFC): The method described by Sakanaka *et al.*[30] was employed to find out the total flavonoid content present in the LCFE. In brief, 250 µL of the extract or catechin standard solution (10-100 µg mL^{-1}, for the preparation of standard calibration curve) was mixed with 1.25 mL of distilled water in a test tube followed by addition of 75 µL of a 5% sodium nitrite solution. After six minutes, 150 µL of a 10% aluminium chloride solution was added and the mixture was allowed to stand for 5 min before 0.5 mL of 1 M sodium hydroxide was added. Distilled water was added to make up the final volume of the reaction mixture to 2.5 mL with and mixed well. Absorbance of the resultant solution was recorded immediately at 510 nm using UV-visible spectrophotometer. The total flavonoid content value was expressed as milligram catechin equivalents (mg CAE)/g per dry extract. All the measurements were done in triplicate.

Determination of Total Tannin Content (TTC): Total tannin content of LCFE was evaluated by the method described by Burns[31]. Samples and standard catechin of required concentration (20-400 µg mL^{-1}) in methanol was prepared in 0.250 mL and were treated with 2.25 mL of reagent mixture consist of 4% vanillin in methanol and 8% concentrated HCl in methanol, in the ratio 4:1. The reaction mixture was vortexed and allowed to stand for 20 min. The developed color of the reaction mixture was recorded at 500 nm by using a UV-visible spectrophotometer. Using the calibration curve prepared using catechin, the total tannins value was expressed as mg catechin equivalents (CAE)/g of dry extract. All the measurements were done in triplicate.

DPPH radical scavenging activity: The DPPH radical scavenging activity of all plant samples and reference drugs were measured according to the method described by Blois[32]. Briefly, 1 mL of DPPH solution (0.2 mM in methanol) was added to 1 mL of the LCFE and reference standards within the concentration range of 5 to 80 µg mL^{-1}. These solutions were incubated in the dark for 30 min at room temperature (25±1°C). The decrease in the absorbance (intensity of purple color) was measured at 517 nm using a UV-visible spectrophotometer. The control consisted of 1:1 ratio of methanol and DPPH solution. This measurement was used to calculate the percentage inhibition using the following formula[30]:

$$\text{Inhibition (\%)} = \frac{\text{Ao} - \text{A1}}{\text{Ao}} \times 100$$

where, Ao is the absorbance of the control, A1 is the absorbance of samples.

Higher the percentage of inhibition, better the radical scavenging activity.

ABTS radical scavenging assay: ABTS radical scavenging activity of all samples, and reference drugs were studied following the procedure described by Re *et al.*[33]. Freshly prepared ABTS solution (5 mL of a 4.9 mM potassium persulphate solution to a 5 mL of 14 mM ABTS solution) and the resulting solution was then kept for 16 hours in the dark,

at room temperature (25±1°C). ABTS reagent solution is stable for two days if kept in the dark and maintained at room temperature. This solution was diluted with methanol to yield an absorbance of 0.700±0.02 at 734 nm and the same solution was used for the ABTS assay. Two ml of the reaction mixture was prepared by mixing 0.1 mL of various concentrations (5-80 μg mL^{-1}) LCFE and other samples and 1.9 mL of ABTS solution. This solution was vortexed for 10 sec, after 6 min the absorbance was recorded at 734 nm using a UV-visible spectrophotometer. The control was prepared by mixing 0.1 mL of methanol with 1.9 mL of ABTS solution. The Percentage inhibition was calculated by using the formula given under DPPH assay.

Ferric Reducing Antioxidant Potency (FRAP): The procedure of Benzie and Strain was followed to determine the ability of the LCFE and the standards[34]. Fresh FRAP reagent was prepared by mixing 10 parts of 300 mM sodium acetate buffer of pH 3.6 with 1 part of 10 mM TPTZ solution and 1 part of 20 mM $FeCl_3 \cdot 6H_2O$ solution, and the reaction mixture prepared was incubated in a water bath at 37°C. Briefly, to a known aliquot of samples (0.2 mL) or reference standards or methanol (control), 3 mL of FRAP reagent was added and incubated at 37°C for 30 min. The increased intensity of blue colour due to the reduction reaction was recorded at 593 nm against the blank solution containing methanol and the reagent. Vitamin C of various concentrations (5-100 μg mL^{-1}) was used for the preparation of standard calibration curve. The FRAP values was expressed as milligram vitamin C equivalent antioxidant capacity (mg VCEAC)/g dry extract.

Total Antioxidant Capacity (TAC) assay: The procedure was followed to determine the antioxidant capacity of the LCFE and standards[35]. To a known aliquot of the sample solution (0.4 mL) in a vial, 4 mL of the reagent solution (0.6 M sulfuric acid, 28 mM sodium phosphate and 4 mM ammonium molybdate) was added and incubated in a water bath for 90 min at 95°C. The blank solution was prepared by mixing 4 mL of reagent solution and 0.4 mL of methanol. After cooling the reaction mixtures to room temperature, absorbance was measured at 695 nm against blank. Vitamin C calibration curve was prepared by using standard solution of ascorbic acid (5-100 μg mL^{-1}) and the antioxidant activity was expressed as mg VCEAC/g dry extract. Increased absorbance in the reaction mixture indicates increased total antioxidant activity of samples tested.

Determination of antimicrobial activity by broth dilution method: In this method, liquid growth media (nutrient broth) containing LCFE and chloramphenicol of two fold increasing concentration were inoculated with the freshly cultured bacterial cell suspension of defined number of bacterial cells (McFarland 0.5)[36]. The control tube contains only media without any sample. The antimicrobial activity was generally determined by measuring the turbidity or colour developed using redox-indicators and was expressed as Minimum Inhibitory Concentration (MIC)[37]. It refers to the minimum concentration of the antimicrobial agent which inhibits the visible growth of the microorganisms under define condition[36].

Evaluation of preservative effect of LCFE and its application as a natural colorant: In order to evaluate the applicability of the LCFE as a natural colorant with preservative action, 10% sugar solution was prepared and was diluted with extract to obtain different concentration (0.25-1%) of LCFE (in triplicate) and filtered to obtain the clear juice. The standard preservative BHT was also prepared at a concentration of 0.5% in the sugar solution and used for the comparative studies. All these test tubes were aseptically inoculated with the microbe (*S. aureus* and *E. coli*) using an inoculation loop except control. Lid of the test tubes were covered with a cotton plug and observed for the growth of microorganisms in terms of turbidity on 7th, 14th and 28th day. The whole procedure was carried out under aseptic conditions.

Statistical analysis: All assays were carried out in triplicates and the results were presented as Mean± SD (N = 3). Analysis of variance (one way ANOVA) was performed and the significant differences between mean values were determined by Tukey's pair wise test at a level of significance of $p<0.05$. The statistical analyses were carried out using SPSS 19 (SPSS Inc., USA).

RESULTS

Total phenolic content, flavonoid content and tannin content: The *Lantana camara* Flower Extract (LCFE) obtained was reddish brown in color with slightly sticky consistency and of 8.4% yield. It is evident from the Table 1 that the flower

Table 1: Total phenolic content, flavonoid content and tannin content values of LCFE (n = 3)

Phenolic content	Values
TPC (mg GAE/g)	52.5±7.0^{c}
TFC (mg CAE/g)	31.8±3.0^{a}
TTC (mg CAE/g)	39.4±2.4^{b}

TPC: Total phenolic content, TFC: Total flavonoid content, TTC: Total tannin content, values with different alphabetical superscripts indicates significant difference ($p<0.05$)

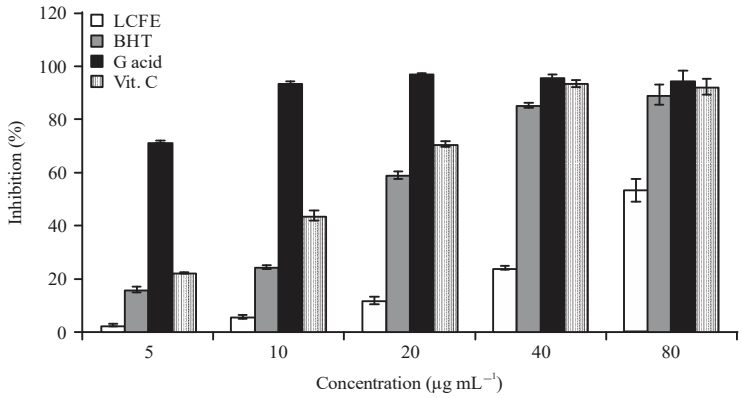

Fig. 1: DPPH radical scavenging activity
LCFE: *Lantana camara* flower extract, BHT: Butylated hydroxyanisole, G acid: Gallic acid, Vit C: Vitamin C

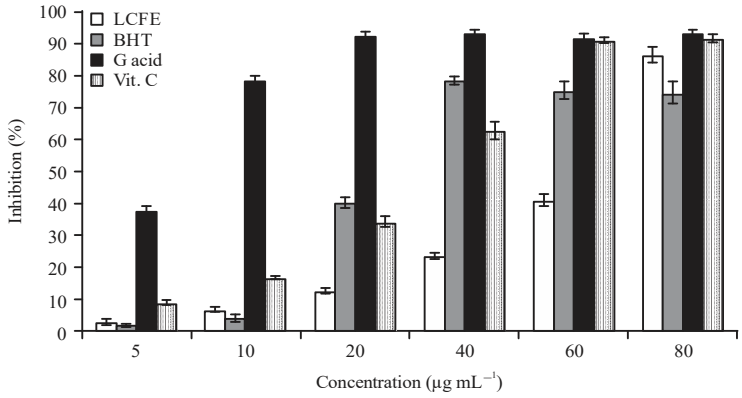

Fig. 2: ABTS radical scavenging activity
LCFE: *Lantana camara* flower extract, BHT: Butylated hydroxyl toluene, G acid: Gallic acid, Vit C: Vitamin C

extract contained considerably higher amount of total phenolic content followed by the tannin content and total flavonoid content.

DPPH and ABTS radical scavenging activities: Figure 1 and 2 depicts the DPPH and ABTS radical scavenging ability of LCFE, BHT, gallic acid and vitamin C. It is evident from data that the radical scavenging capacity is concentration dependent. In the DPPH assay at all the concentration tested, Gallic acid showed highest activity followed by vitamin C, BHT and LCFE. Except LCFE, remaining all samples showed maximum DPPH radical scavenging activity at the concentration of 80 µg mL^{-1}. However in ABTS assay, the scavenging activity was in the order of Gallic acid>vitamin C>LCFE>BHT. In this assay, all samples showed maximum DPPH radical scavenging activity at the concentration of 80 µg mL^{-1} except BHT.

Results of reducing capacity of LCFE, BHT and gallic acid are depicted in the Fig. 3. It is evident from the Fig. 3 that among the tested samples, gallic acid possessed highest reducing capacity in both assays followed by LCFE and BHT. The reducing capacity of LCFE was three times lesser than gallic acid, but two time more than BHT and almost four times lesser than gallic acid and two time higher than BHT in FRAP and TAC assays, respectively.

Antimicrobial activity of LCFE and chloramphenicol: Results of the antimicrobial activity studied against five food spoilage pathogen revealed good antimicrobial activity in terms of minimum inhibitory concentration against *E. coli* and *P. aeruginosa* and moderate activity against *Shigella* and *S. typhi* and lowest activity against *S. aureus* (Table 2). However, the found activity was significantly lesser than the activity exhibited by standard chloramphenicol

Preservative activity of the extract and its coloring efficacy: Preservative efficacy was studied against only two food pathogen. Table 3 illustrated the results of the preservative effect of LCFE and it is evident that the concentration of the

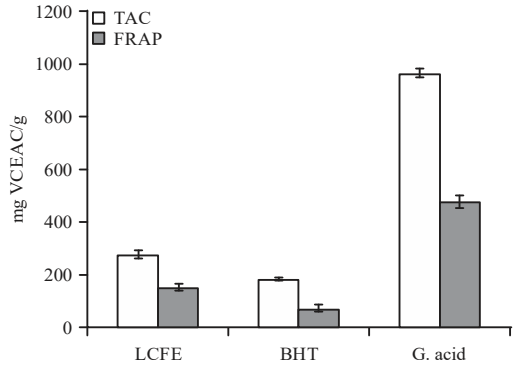

Fig. 3: Total Antioxidant Capacity (TAC) and Ferric Reducing Ability of Plasma (FRAP) of samples
LCFE: *Lantana camara* flower extract, BHT: Butylated hydroxyanisole, G acid: Gallic acid, VCEAC: Vitamin C equivalent antioxidant capacity

Table 2: Minimum inhibitory concentration of LCFE and chloramphenicol (n = 3)

	MIC (µg mL^{-1})				
Name of the sample	*E. coli*	*S. aureus*	*Shigella*	*S. typhi*	*P. aerugionosa*
LCFE	500	1000	750	750	500
Chloramphenicol	30	15	15	30	15

LCFE: *Lantana camara* flower extract, MIC: Minimum inhibitory concentration

Table 3: Preservative efficacy of LCFE and BHT at different concentration

	E. coli			*S. aureus*		
Samples	Day 7	Day 14	Day 28	Day 7	Day 14	Day 28
Juice (0.25% LCFE+MO)	+++	++	++	++	++	+++
Juice (0.5% LCFE+MO)	+++	+	+	++	+	-
Juice (0.75% LCFE+MO)	++	+	+	+	+	-
Juice (1% LCFE+MO)	+	-	-	+	-	-
Juice (0.5% BHT+MO)	+	-	-	+	-	-
Juice with MO	++++	++++	++++	+++	++++	++++
Sugar juice	+++	++++	++++	++	+++	++++

-: No growth of microbes, +: Least growth of microbes, ++: Average growth, +++: Moderate growth, ++++: Maximum growth of microbes, LCFE: *Lantana camara* flower extract, BHT: Butylated hydroxyanisole, MO: Microorganism

LCFE in the juice increased the preservative efficacy in terms of inhibition of the growth of the microbe was also increased. At the end of 28th day, the highest concentration tested (1% LCFE) showed no growth of microbes, however, it was present during the 7th day of incubation. Moreover, standard preservative (BHT, 0.5%) did not shown any growth of microbes even after 28 days. In terms of the color intensity, as the concentration of the LCFE was increased the corresponding visual intensity of the color of the juice was found to increase.

DISCUSSION

Plant extracts are considered as natural sources of antioxidants and antimicrobials with nutritional benefit. They are very safe and easily biodegradable[13]. In the present study the flower of *Lantana camara* was studied for its application as a natural preservative and colorant. In general, to extract the colorants from plants solvent extraction method was employed using water or alcohol as extracting solvents. Hence, in the present study hydroalcohol was employed to extract the fresh flower as the drying of *Lantana camara* flower led to the degradation of color. Sonication method was employed to extract the flower as it is a very rapid method and prevent the degradation of coloring pigments from prolonged exposure to solvent. The amount of extract obtained in this study was considerably higher and easily soluble in water. In addition, results of total phenolic content revealed that *Lantana camara* flower extract possessed significant amount total phenolics in comparison with total flavonoid and tannin content.

Antioxidant activities were carried out in terms of the determination of DPPH and ABTS radicals scavenging activity as well as reducing capacity of ferric and phosphomolybdenum. Radical scavenging activity of LCFE extract was in comparison with that of synthetic antioxidant BHT at the concentration of 80 µg/ml in both assay. However, the reducing capacity of the flower extract was significantly higher than BHT but lesser than plant bioactive compound gallic acid. The correlation study between the phenolic contents and antioxidant activity revealed the strong correlation indicating the influence of phenolic content for the found antioxidant activity. Similar findings were reported by Annegowda *et al.*[38] revealing correlation between the phenolic content and antioxidant activity of *Terminalia catappa* leaf extract.

The antimicrobial activity of the flower extract was determined by broth dilution method and the activity was expressed in terms of MIC (mg mL^{-1}). The antimicrobial activity was evaluated against five potent food pathogens like *E. coli, S. aureus, Shigella, S. typhi* and *P. aeruginosa*[13]. The LCFE showed good antimicrobial activity against Gram-negative bacteria compared to Gram-positive bacteria. *E. coli* and *P. aeruginosa* were found to be more sensitive and *Shigella* and *S. typhi* were moderately sensitive followed by *S. aureus* microbes. It may be presumed that the extent of antioxidant and antimicrobial activity are might be due to the presence of phenolic compounds and essential oils found in the plant extract[39]. Earlier, various researchers reported the presence of flavonoids, phenolic, alkaloids and essential oils from the leaves of this plant[22-26]. These bioactives may interact with the enzymes and proteins of bacterial cell membrane leading to the disruption of cell wall and discharge of cytoplasmic content which finally results in death of bacteria[13].

The occurrence of food borne diseases was estimated more than 76 million in USA alone with around 5000 deaths annually. Hence, the synthetic preservatives like BHA, BHT, calcium propionate, sulphur dioxide and nitrate, etc., are added to increase the shelf life of the preparations[10]. Preservative are grouped into three types, first type are antimicrobials prevent the growth of microorganism, second type preservative are antioxidants which prevents the oxidation of biologically active ingredients and third types are antibrowning agents which prevent the enzymatic browning of fruits and vegetable[40]. Repeated application of them resulted in the accumulation of these chemical residues in food leads to the severe adverse effects along with the existence of microbial resistance[13]. In this regard, medicinal and aromatic plants have emerged as an alternative to synthetic preservatives due to the presence of higher phenolic content with nutritional value and in some plants they provide appealing color. Since the *Lantana camara* flower extract possessed considerable amount of phenolic content with good antioxidant and antimicrobial activity, it is further evaluated for its preservative action and as natural colorants. Earlier, food products can be preserved from food borne disease caused by *S. aureus, B. cereus, E. coli* and *S. typhi* using the plant extracts with good antimicrobial activity[41]. Findings of the present study was comparable with the results of Cruz *et al.*[42], wherein ethanolic extract of Mangrove leaf exhibited highest antioxidant activity with moderate antimicrobial activity proved to be a potential natural coloring agent at the concentration of 1, 3 and 5%.

The results of the preservative efficacy of the LCFE revealed that at the lower concentration of 0.25% of the extract added to sugar juice shown the presence of the growth of growth of *E. coli* after 7th day, but at the same concentration *S. aureus* shown the growth after 14th day when stored at room temperature. As the concentration increased the growth of the pathogenic microbes was decreased. At a concentration of 1% of the extract against *S. aureus* the there were no signs of growth of microbes after 28th day and it was in comparison with the results of the synthetic antioxidant BHT. However, in the control test tube which contained only sugar juice when compared with that of test tubes containing juice with the microbes, sign of microbial growth was evident from the 5th and 2nd day of the inoculation, respectively. Since the antimicrobial activity was encouraging, use of *Lantana camara* flower extract can be incorporated for the preservative activity as well. The plant extracts with antimicrobial activity could be exploited as a natural preservative, an alternate to the synthetic preservatives[13]. In addition to the preservative action, samples were imparted with light reddish brown color and the intensity of the color is based on the concentration. As the growth of the microbes in the test tubes increased correspondingly there was change in the color of the samples in the test tubes indicating the degradation of the bioactives responsible for the preservative action as well as coloring properties.

Most of the studies related to medicinal and aromatic plants are either related to the evaluation of preservative efficacy or the incorporation of the extract as a natural colorant. The present study is of its kind in exploiting the application of both colorant and preservative property of the plant extract. Further study is in progress to determine the insoluble matrix, total ash, acid insoluble ash and moisture content of the extract. Since the natural colorants are less stable at all the temperature, pH and light, further study is warranted to study the color value, stability of the extract to light, heat and pH.

The findings of the study implied that plants could prove to be a potential source of natural colorant and preservatives and may find its suitable applicability in food as well as pharmaceutical industries, however their usage can be related to the stability aspect which could be a limitation, thus, it is recommended that stability studies be undertaken in presence of light, heat and pH to rule out any sort of limitations.

CONCLUSION

The present study established the link between the amount of phenolic component present in the *Lantana camara* flower extract being proportional to free radical scavenging and reducing capacity. In addition, the presence of these phenolic components with antioxidant activity ensured the moderate antimicrobial potency which can prevent the spoilage caused by food pathogens. The present study also showed the suitability of the *Lantana camara* flower extract for its preservative efficacy with coloring properties. Hence, *Lantana camara* flower extract can be utilized as source of natural preservative with coloring properties to overcome the complications associated with synthetic colorants and preservatives. Further study can be undertaken to demonstrate the possible effect of temperature, pH, light and food additives on this flower extract when used in the formulation.

SIGNIFICANCE STATEMENT

This study discovered that, *Lantana camara* flower extract can be advocated as a potential source of natural coloring agent along with the preservative activity, wherein, the

preservative activity was almost comparable to that of the synthetic standard (BHT) and minimize or overcome the likely toxic effects associated with the synthetic chemicals. The findings of this study will enable researchers to use plants as an alternate potential source of coloring and preservative agents.

ACKNOWLEDGMENTS

The researchers are grateful to acknowledge Rajiv Gandhi University of Health Sciences, Karnataka, India for research grant RGU: Adv. Res.: Proposal-P-166 for considering and acknowledging the project with a financial aid.

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