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Mathematical approach to analysis of therapeutic properties of four important flowers mentioned in Siribhoovalaya- An ancient Indian multilingual manuscript

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Pushpayurveda is considered to be a unique branch of ayurvedic medicine which was first conceived by Jain monks as early as 9th century. Various ancient Indian manuscripts contain notes about the use of flowers for medicinal applications. The petals of flowers could be directly administered orally or can be made into the form of juice, decoction and or by mixing with other active ingredients. 'Siribhoovalaya', a multilingual literature written by Jain monk Kumudendu muni mentions the application of eight important flowers for the purification of mercury. In the present study, the antibacterial and antioxidant analysis of extracts of four of the eight mentioned flowers- Panasa, Padari, Kedige, Krishnapushpa was carried out. The results of antioxidant analysis were studied in detail with the help of modern mathematical software MATHEMATICA. Combination of all four flowers was found to be effective against *B. cereus*, *S. aureus* and *S. marcescenes*. The antioxidant activity was found reduced when a combination of the four flowers were used. The extract of Ketaki showed significantly higher antioxidant activity compared to all the other extracts. The whole study is carried out based on the standard tests of hypotheses, using ANOVA and the correlation effect is studied using regression models.

Keywords: *Artocarpus heterophyllus*, Mathematical modeling, *Pandinus odoratissimus*, *Passiflora foetida*, Pharmacological studies, Pushpayurveda, *Stereospermum xylocarpa*

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Ayurveda is one of the well-known systems of medicine since Vedic times. Plants represent the primary source of medicine in ayurvedic treatments. Various parts of plants such as roots, fruits, stem barks, rhizomes, seeds and flowers are used in the treatment of various diseases in descending order. Flowers have always had distinct place in Ayurvedic treatment since time immemmorial[1]. Pushpayurveda, a branch of Ayurvedic medicine first discovered by Jain priests of ancient India is considered as an exceptional branch of Ayurvedic medicine[2,3]. Jain monks of ancient India in their scripts related to Pushpayurveda have cited pharmacological applications of more than 18,000 types of flowers. This ideal line of treatment involving the application of flowers was given priority by Jains and Buddhists as it strictly follows the "ahimsa dharma" - does not harm any living being. According to the Rigveda (sacred), "one who is well aware of pushpas or flowers will always be blessed with prosperity, health, riches and good fortune"[4]. Siddha vaidya branch of medicine also describes the therapeutic importance of flowers of medicinal plants. Application of flowers in ayurvedic treatment is vividly portrayed as it results in considerable prosperity (Kalyana karakam). The colour and the fragrance of flowers are highly magnificent and they have a positive effect on the mood. They could be helpful in healing emotional trauma such as grief, shock, depression, fear, terror, hysteria and anxiety. Flowers can be administered directly by eating petals or can be made into the form of juice, decoction and or by mixing with some or few other ingredients[1]. Several reports on the application of flowers in treating the major and minor ailments are available in the literature. The therapeutic efficacy of flowers such as priyangu, dhataki, lodhra, padma, nandivrruksha have already been quoted by Vaghbata for the treatment of diarrhea, to heal fractures, in treating ulcers etc[5]. Floral formulations have been used to treat diarrhea, liver disease, cough, menorrhagia and bleeding piles. Application of eight important flowers such as Nagasampige, Nagamallige, Panasa, Padari, Kedige, Krishnapushpa, Maadiphala and Shankapushpa for purification of

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mercury, an ingredient in many ayurvedic formulations has already been mentioned in Siribhoovalaya, a multilingual literature written by ancient Jain monk Kumudendu muni[6]. Pleasant tasting roots and fragrant flower Padari has antipyretic properties and is aphrodisiac in nature[7]. Kedige flowers are mainly used to cure scalp and skin ailments. The anthers of kedige flowers are used to treat epilepsy and sore throat[8]. Krishnapushpa or passion flower has various pharmacological properties such as antispasmodic, sedative, anxiolytic and hypotensive activity[9]. A particular chemical component of Krishnapushpa has been found to have antimicrobial activity[10].

Although several reports on pharmacological applications of various medicinal important flowers are available in the literature, elucidation of their potential through mathematical approach has never been attempted earlier. The present study mainly focuses on the elucidation of therapeutic application of four flowers Panasa, Padari, Kedige and Krishnapushpa out of the eight flowers mentioned in Siribhoovalaya through a novel mathematical approach.

Materials and Methods

Collection of flowers

Samples of the four fresh full bloomed flowers listed in this study were collected from in and around Western Ghats, Karnataka, India. These floweres were taxonomically identified based on plant morphology and floral characteristics by botanist Dr. Nagananda G S as follows: *Artocarpus heterophyllus* (Panasa) (Fig. 1a); *Stereospermum xylocarpum* (Padari) (Fig. 1b); *Pandinus odoratissimus* (Kedige) (Fig 1c); *Passiflora foetida* (Krishnapushpa) (Fig. 1d). Generic names of the flowers will be used wherever applicable henceforth.

Cold successive extraction

Ten grams of fresh flowers (Panasa, Padari, Kedige and Krishnapuspha) were soaked in methanol for 20 days at 25°C under continuous shaking at 100 rotations per minute. The solvent obtained was decanted and the samples were then concentrated using rotary vacuum evaporator. Further studies were carried out using the resultant dried extracts[11].

Qualitative phytochemical screening

The floral extracts were subjected to phytochemical profiling[12]. The different qualitative chemical tests for alkaloids[13-15], phytosterols[16], phenols[17] and flavonoids[18], were performed for establishing phytochemical constituents present in floral extracts.

Fig. 1 — Plants with flower collected from Western Ghats for the study. a- *Artocarpus heterophyllus* (Panasa), b- *Stereospermum xylocarpa* (Padari), c- *Pandinus Odoratissimus* (Kedige), d- *Passiflora foetida* (Krishnapushpa)

Quantitative analysis of secondary metabolites of floral extract

(a) ***Estimation of phytosterols by Libermann-burchard method:*** To different aliquots of standard cholesterol, 2 mL of acetic anhydride followed by 1-2 drops of concentrated H_2SO_4 was added. The reaction mixture was incubated in dark for 15 minutes. Floral extracts earlier dissolved in 1 mL of chloroform was mixed with 2 mL of acetic anhydride and incubated in dark for 15 minutes. The absorbance of this was measured at 640 nm[16].

(b) ***Estimation of total flavonoid content by Aluminium Chloride method:*** Different aliquots (0.2-1 mL) of standard Quercetin (1mg mL^{-1}) solution were taken in a series of test tubes. Five hundred micro liter of floral extract was mixed with 2 mL of distilled water and subsequently with 0.15 mL of 5% $NaNO_2$ solution. After around 6 minutes of incubation, 0.15 mL of a 10% $AlCl_3$ solution was added and this was allowed to stand for 6 min. further, 2 mL of 4% NaOH solution was added to the mixture followed by the addition of distilled water to bring the final volume of 5 mL. The mixture was thoroughly mixed and allowed to stand at room temperature for 15 minutes. Absorbance was measured at 510 nm[18].

(c) ***Estimation of total phenols:*** 0.5 ml of Folin-Ciocalteau reagent was added to the floral extracts. The tubes were shaken well and held at room temperature for three minutes. Further, 2 ml of 20% Na_2CO_3 solution was added to each tube and the tubes were mixed thoroughly post which they were placed in boiling water bath for one minute. The absorbance was measured at 650 nm[17].

Antioxidant activity of floral extracts

(a) ***DPPH assay***: Free radical scavenging activity on 1, 1-diphenyl-2-picrylhydrazyl (DPPH)[19]. Standard ascorbic acid and floral extracts (1 mg mL^{-1}) at various concentrations (10-50 µg mL^{-1}) were taken. Five milliliter of a 0.1 mM methanolic solution of DPPH was added and tubes were kept aside in dark at room temperature for 20 minutes. The absorbance of the sample was measured at 517 nm. All experiments were performed in triplicates[20]. Radical scavenging activity was expressed as percentage of inhibition of free radical by the sample and was calculated using the following formula:

$$DPPH\ radical\ scavenging\ activity\ (\%) = \frac{Control\ OD - Sample\ OD}{Control\ OD} \times 100$$

(b) ***ABTS (2, 2-azinobis (3-ethylbenzothiazoline-6-sulfonic acid)) radical cation decolorization assay*:** Standard ascorbic acid and sample extracts (1 mg mL^{-1}) at various concentrations (10-50 µg mL^{-1}) were taken and the volume was adjusted to same in all with DMSO. Three hundred micro liter of prepared ABTS solution and 3 ml of ethanol were added, incubated in dark for 30 minutes at room temperature. The absorbance of the reaction mixture was read at 745 nanometer. All experiments were performed in triplicate[20]. Radical cation decolorization activity was expressed as the inhibition percentage of cations by the sample and was calculated using the following formula:

$$ABTS\ radical\ scavenging\ Activity\ (\%) = \frac{Control\ OD - Sample\ OD}{Control\ OD} \times 100$$

IC_{50} value: IC_{50} values were calculated from the regression equation, prepared from the concentration of the samples and percentage inhibition of free radical formation. Ascorbic acid was used as positive control and all tests were carried out in triplicates.

Antimicrobial assay

Source of microorganisms: Clinical isolates of bacteria were sourced from Azymes Bioscience Pvt. Ltd., Bangalore, India and were maintained at optimum conditions. The test bacterial pathogens included *Bacillus cereus* (*B. cereus*), *Escherichia coli* (*E. coli*), *Staphylococcus aureus* (*S. aureus*) and *Serratia marcescens* (*S. marcescens*).

Assay of antibacterial activity: Antibacterial activities of all the 4 floral extracts were studied by agar well-diffusion method[22]. Test cultures of the bacterial pathogens were prepared by transferring a loop full of bacteria from nutrient agar slants into Mueller Hinton broth and incubated at 37±1°C for 2 h. Lawn cultures of the test pathogens were prepared by swabbing sterile Mueller Hinton agar plates with 24 hour old bacterial broth. Wells were punched with a sterile cork borer (6 mm internal diameter). 100 µL of the extracts were added to each of the well. Controls were maintained with DMSO. Streptomycin (100 µg mL^{-1}) dissolved in DMSO was used as standard antibiotic. Plates were incubated at 37 °C for 24 h, diameters of the inhibitory zones were measured to the nearest millimeter.

Statistical analysis

Analysis of variance was conducted by two way ANOVA. All statistical analysis was performed at 1% significance level using the tool 'MATHEMATICA'.

Results and Discussion

Qualitative phytochemical screening

Different qualitative chemical tests were performed for establishing phytochemical profile of four different flower extracts. Phytochemical screening performed on all the extracts revealed the presence of flavonoids, phenols and phytosterols (Table 1).

Quantitative estimation of phytochemicals

The quantitative estimations of the phytochemicals, which were qualitatively detected in the floral extracts of *P. odoratissimus* revealed the presence of high flavanoid content (195.8 µg mL^{-1}), high phenol content (51.36 µg mL^{-1}) and high content of phytosterol (92.25 µg mL^{-1}) content when compared to other floral extracts (Table 2).

Antioxidant activity: Figure 2a & b represent the antioxidant activity of all four floral extracts and their combination with respect to DPPH and $ABTS^{+}$ methods. Kedige extract exhibited highest antioxidant activity compared to all other extracts in both the cases. The antioxidant activity was found reduced when a combination of the four floral extracts were used. Table 3 depicts the correlation coefficient

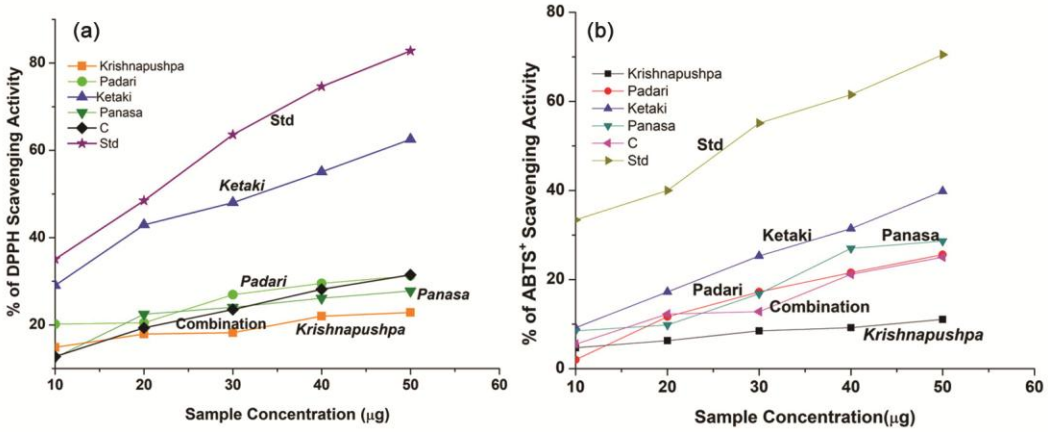

Fig. 2 — a & 2b: DPPH and ABTS$^+$ Scavenging Activity of Panasa, Padari, Ketaki, Krishnapushpa and their combination at different concentrations

Table 1 — Phytochemical Screening of Floral Extracts

Sl. No.	Test		*P. foetida*	*S. chelonoides*	*P. odoratissimus*	*A. heterophyllus*
1.	Phytosterols (Liebermann-Burchards)		+++	+	++++	++
2.	Alkaloids	Mayer's	-	-	-	-
		Dragendroff's	-	-	-	-
3.	Phenols		+	+++	++++	+
4.	Flavonoids		+	+++	++++	++

Table 2 — Quantification of Phytochemicals present in the floral Extracts

Sl. No.	Extracts	Phytosterols (µg/ml)X*± SE	Phenols (µg/ml) X*± SE	Flavonoid (µg/ml) X*± SE
1.	*P. foetida*	61.5±0.023	10.24±0.577	8.8±0.057
2.	*S. xylocarpa*	12.75±0.011	25.25±0.000	70.4±0.461
3.	*P. odoratissimus*	92.25±0.023	51.36±0.288	195.8±0.000
4.	*A. heterophyllus*	28.5±0.023	13.04±0.288	31.9±0.317
5.	Combination	12±0.023	24.16±0.288	78.1±0.317

analysis of floral extracts for both DPPH and ABTS$^+$ methods.

Statistical Analysis

(i) DPPH Method: Figure 3a illustrates the interaction effect of all four floral extracts used in the present study under DPPH method.

1. The computed value of F is 65.8217. The table value of F is 4.43 at the given significance level of 0.01 and degrees of freedom (4, 20). The null hypothesis has to be rejected and alternate hypothesis has to be accepted as the computed value of F (65.8217) is greater than the tabulated value of F (4.43)[23].

a. ***Inference:*** The slopes are $\beta_1 \neq 0, \beta_2 \neq 0, \beta_3 \neq 0, \beta_4 \neq 0$ (i.e. there is linear relationship between Y and X_1, X_2, X_3 and X_4 as shown in the model). The coefficient of determination is $r^2 = 0.9294$ This means that the regression model $Y = 14.9575 + 0.122044\ X_1 + 0.319865\ X_2 + 1.00286$

Table 3 — Correlation Coefficient Analysis of Floral Extracts

TEST	SPECIES PAIR	CORRELATION COEFFICIENT	REMARKS
DPPH	Krishnapushpa & Padari	0.9048	
DPPH	Krishnapushpa & Kedige	0.9738	Highly correlated
DPPH	Krishnapushpa & Panasa	0.9118	
DPPH	Padari & Kedige	0.9191	
DPPH	Padari & Panasa	0.8203	
DPPH	Kedige & Panasa	0.9613	
ABTS	Krishnapushpa & Padari	0.9832	
ABTS	Krishnapushpa & Kedige	0.9960	Highly correlated
ABTS	Krishnapushpa & Panasa	0.9417	
ABTS	Padari & Kedige	0.9843	
ABTS	Padari & Panasa	0.9245	
ABTS	Kedige & Panasa	0.9572	

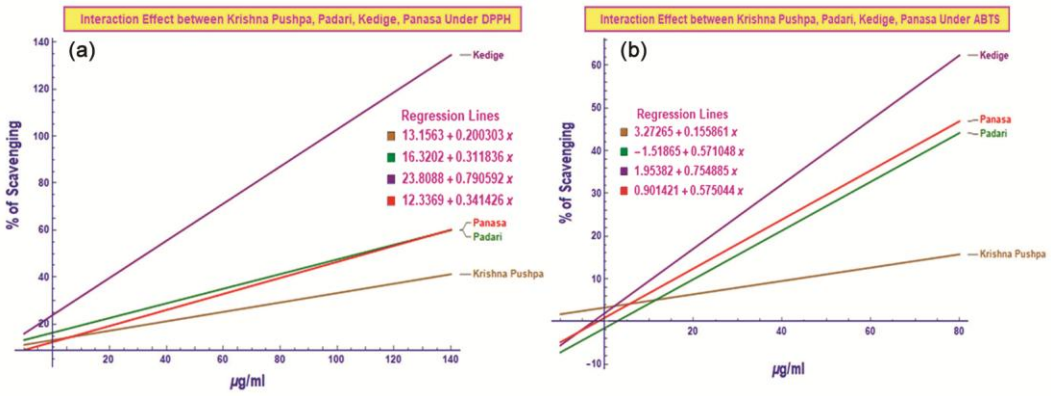

Fig. 3 — a & 3b: Interactive Effects of Panasa, Padari, Ketaki and Krishnapushpa as determined for both DPPH and ABTS$^+$ by varying one variable at a time while keeping the other two fixed

Table 4 — ANOVA Analysis of All Four Flowers and their Combination under DPPH Method

Floral extracts	DF	SS	MSS	F-stat	p value	r^2	r
Krishnapushpa	1	40.1215	40.1215	51.0469	0.005646	0.944	0.972
Error	3	2.35792	0.7859				
Total	4	42.4794					
Padari	1	97.2418	97.2418	39.5569	0.008118	0.929	0.964
Error	3	7.3748					
Total	4	104.617	2.45828				
Kedige	1	625.035	625.035	97.9696	0.002193	0.97	0.985
Error	3	19.1397	6.37987				
Total	4	644.175					
Panasa	1	116.572	116.572	13.3716	0.035326	0.816	0.903
Error	3	26.1536	8.71786				
Total	4	142.726					
Combination	1	214.205	214.201	209.516	0.000714	0.985	0.993
Error	3	3.06714	1.02238				
Total	4	217.272					

X_3 + 0.240819X_4 explains 92.94% difference in Y when compared to the total difference and the correlation coefficient $r = \sqrt{r^2} = 0.96405$. (Table 4)

2. The calculated value of F is 51.0469. At significance level of 0.01, the table value of F with (1, 3) degree of freedom is 34.12. The Null hypothesis has to be rejected and alternate hypothesis has to be accepted since in this case the calculated value of F (51.0469) is more than the table value of F (34.12)

a. ***Inference:*** The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_1as shown in the model). The coefficient of determination is r^2=0.944. This indicates that the regression model $Y = 13.15 + 0.2003\, X_1$ clarifies 94.4% variation in Y when compared to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.972$.

3. The computed value of F is 39.5569. From the tables, value of F with (1, 3) degrees of freedom at a significance level of 0.01 is 34.12. In this case, the null hypothesis has to be rejected since the calculated value of F (39.5569) is more than table value of F (34.12). The alternate hypothesis has to be accepted.

a. ***Inference:*** The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_2 as shown in the model). The coefficient of determination is r^2 = 0.929. This means that the regression model $Y = 16.3202 + 0.311836\, X_2$ explains 92.9% dissimilarity in Y when related to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.964$.

4. The table value of F with (1, 3) degrees of freedom at the given significance level of 0.01 is 34.12. The calculated value of F in this case is 97.9696. As we

see, the calculated value is more than the table value of *F* and hence the null hypothesis has to be rejected and alternate hypothesis accepted.

a. ***Inference:*** The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_3as shown in the model). The coefficient of determination is r^2= 0.97. This indicates the regression model $Y = 23.8088 + 0.790592\,X_3$ explains 97% variation in Y when compared to total variation and the correlation coefficient $r = \sqrt{r^2} = 0.985$.

5. The calculated value of *F* in this case is 13.3716. As obtained from statitstical tables, the table value of F is 10.13 with (1, 3) degrees of freedom at a significance level of 0.05. Here the calculated value of *F* (13.3716) is higher than the table value of *F* (10.13). Hence, we can accept the alternate hypothesis and reject the null hypothesis.

a. ***Inference:*** The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_4as shown in the model). The coefficient of determination is r^2= 0.816. This means that the regression model $Y = 12.3369 + 0.341426\,X_4$ explains 81.6% difference in Y when related to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.903$.

6. ***Combinatorial effect:*** In this experiment the value of F calculated is 209.516. At (1, 3) degrees of freedom and significance level of 0.01, the table value is 34.12. Here the calculated value of *F* is more than the table value of *F* and we can safely reject the null hypothesis and accept the alternate hypothesis.

a. ***Inference:*** The slope is $\beta_1 \neq 0$ (i.e. A linear relationship between Y and X_5 is observed as shown in the model). The coefficient of determination is r^2= 0.985. This means that the regression model $Y = 9.1654 + 0.4628\,X_5$ implies 98.5% variation in Y when related to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.993$.

(ii) ABTS Method: Figure 3b demonstrates the interaction effect of all four floral extracts under $ABTS^+$ method.

1. The calculated value of *F* is 166.895. The table value of *F* with (4, 20) degrees of freedom at the given significance level of 0.01 is 4.43. As observed, the calculated value of *F* (166.895) is higher than the table value of *F* (4.43). Hence, we can reject the null hypothesis and accept alternate hypothesis.

a. ***Inference:*** The slopes are $\beta_1 \neq 0$, $\beta_2 \neq 0$,$\beta_3 \neq 0$,$\beta_4 \neq 0$ (i.e. as shown in the model, there is linear relationship between Y and X_1, X_2, X_3 and X_4). The coefficient of determination is r^2 = 0.974 and this indicates that the regression model $Y = 1.1127 + 0.2068\,X_1 + 0.4913\,X_2 + 0.7699\,X_3 + 0.5613\,X_4$ clarifies 97.4% variation in Y when compared to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.985$. (Table 5)

2. The calculated value of *F* is 179.506. At a significance level of 0.01 and (1.3) degrees of freedom the table value of *F* is 34.12. Since, the calculated value of *F* (179.506) is more than the table value of *F* (34.12) we can reject the null hypothesis and admit the alternate hypothesis.

a. ***Inference:*** The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_1as shown in the model). The coefficient of determination is

Table 5 — ANOVA Analysis of All Four Flowers and their Combination under $ABTS^+$ Method

Floral extracts	DF	SS	MSS	F-stat	p value	r^2	r
Krishnapushpa	1	24.2928	24.2928	179.506	0.00089	0.983	0.992
Error	3	0.40599	0.1353				
Total	4	24.6988					
Padari	1	326.096	326.096	77.5265	0.003087	0.962	0.981
Error	3	12.6187	4.20625				
Total	4	338.715					
Kedige	1	569.851	569.851	1479.52	0.000038	0.998	0.999
Error	3	1.15548	0.385159				
Total	4	571.006					
Panasa	1	330.676	330.676	44.2787	0.006917	0.936	0.968
Error	3	22.4042	7.46807				
Total	4	353.08					
Combination	1	230.417	230.417	65.2014	0.003968	0.956	0.978
Error	3	10.6018	3.53393				
Total	4	241.019					

r^2= 0.983. This means that the regression model $Y = 3.2726 + 0.1558X_1$, explains 98.3% difference in Y when compared to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.992$.

3. At a significance level of 0.01 and (1.3) degrees of freedom the table value from statistical tables is 34.12. The calculated value of *F* is 179.506. Here, the table value is less than the calculated value and hence, we can safely reject the null hypothesis and accept the alternate hypothesis.

a. ***Inference****:* The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_2as shown in the model). The coefficient of determination is r^2= 0.962. A 96.2% variation means that the regression model $Y = -1.5186 + 0.5710X_2$ explains 96.2% variation in Y when related to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.981$.

4. At a significance level of 0.01 and (1.3) degrees of freedom the table value from statistical tables is 34.12 and the calculated value of *F* is 1479.52. As we can see, the calculated value is higher than the table value and we can hence safely the null hypothesis and accept the alternate hypothesis.

a. ***Inference****:* The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_3as shown in the model). The coefficient of determination is r^2= 0.998. This suggests that the regression model $Y = 1.953 + 0.7548X_3$ explicates 99.8% variation in Y when compared to the overall variation and the correlation coefficient $r = \sqrt{r^2} = 0.999$.

5. As observed, the table value of *F* with (1, 3) degrees of freedom at the given significance level of 0.01 is 34.12. The calculated value of the same is 44.2787. It is clear that the calculated value is higher than the table value in this case and hence it is safe to reject the null hypothesis and accept the alternate hypothesis.

a. ***Inference****:* The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_4as shown in the model). The coefficient of determination is r^2= 0.936. This means that the regression model $Y = 0.9014 + 0.5750X_4$ explains 93.6% variation in Y when compared to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.968$.

6. ***Combinatorial effect:*** As observed, the table value of *F* with (1, 3) degrees of freedom at the given significance level of 0.01 is 34.12. The calculated value of the same is 65.2014. It is evident that the calculated value is higher than the table value in this case and hence it is safe to reject the null hypothesis and accept the alternate hypothesis.

a. ***Inference****:* The slope is $\beta_1 \neq 0$ (i.e. there is linear relationship between Y and X_5as shown in the model). The coefficient of determination is r^2= 0.956. This suggests that the regression model $Y = 0.954 + 0.48X_5$, clarifies 95.6% variation in Y when compared to the total variation and the correlation coefficient $r = \sqrt{r^2} = 0.978$.

Antibacterial activity of Krishnapushpa, Panasa, Kedige, Padari and their combination: Figure 4 illustrates the antibacterial activity of all four flowers used in the study. Krishnapushpa exhibited highest antibacterial activity against *B. cereus*, *S. aureus* and *S. marcescene*. *E. coli* was found to be resistant to all the four flower extracts. Combination of all four flowers (Krishnapushpa, Padari, Kedige and Panasa) was found to be effective against *B. cereus*, *S. aureus* and *S. marcescenes*. Panasa, Kedige and Padari were found to be effective against *B. cereus* and *S. aureus* whereas *E. coli* and *S. marcescenes* were found to be resistant (Fig. 4).

Krishnapushpa species have been extensively used in folk medicine against several diseases. In Brazil, Krishnapushpa is used as lotions or poultices for erysipelas and skin diseases characterized by inflammation. Similarly, Kedige pushpa (*Pandinus odoratissimus*) removes "kapha vata" as it possesses cleansing properties.

India is blessed with a very rich flora which includes enormous number of medicinal plant wealth. This treasure was widely used by the indigenous system of medicine like Ayurveda and Siddha[4]. Records indicate that ethnic tribes and rural folk use at least 2500 species of medicinal herbs to manage their ailments[24]. Although exploitation of several parts of plants for pharmacological aspects has been well documentad since time immemorial; not many reports are available on the application of floral extract for the treatment of ailments. Flowers possess a comprehensive biochemical profile that includes alkaloids, flavonoids, tannins, triterpenoids, glucosides, saponins, phytosterols, phenols etc. These secondary metabolites of flowers indeed exhibit diverse biological activities such as antioxidant, antimicrobial, hyperglycemic etc. The biochemical profile of flowers varies from that of the other parts of the plant. For instance, high phenolic content, gallic acid and quercetin is found in floral parts compared to other parts of the plant[25].

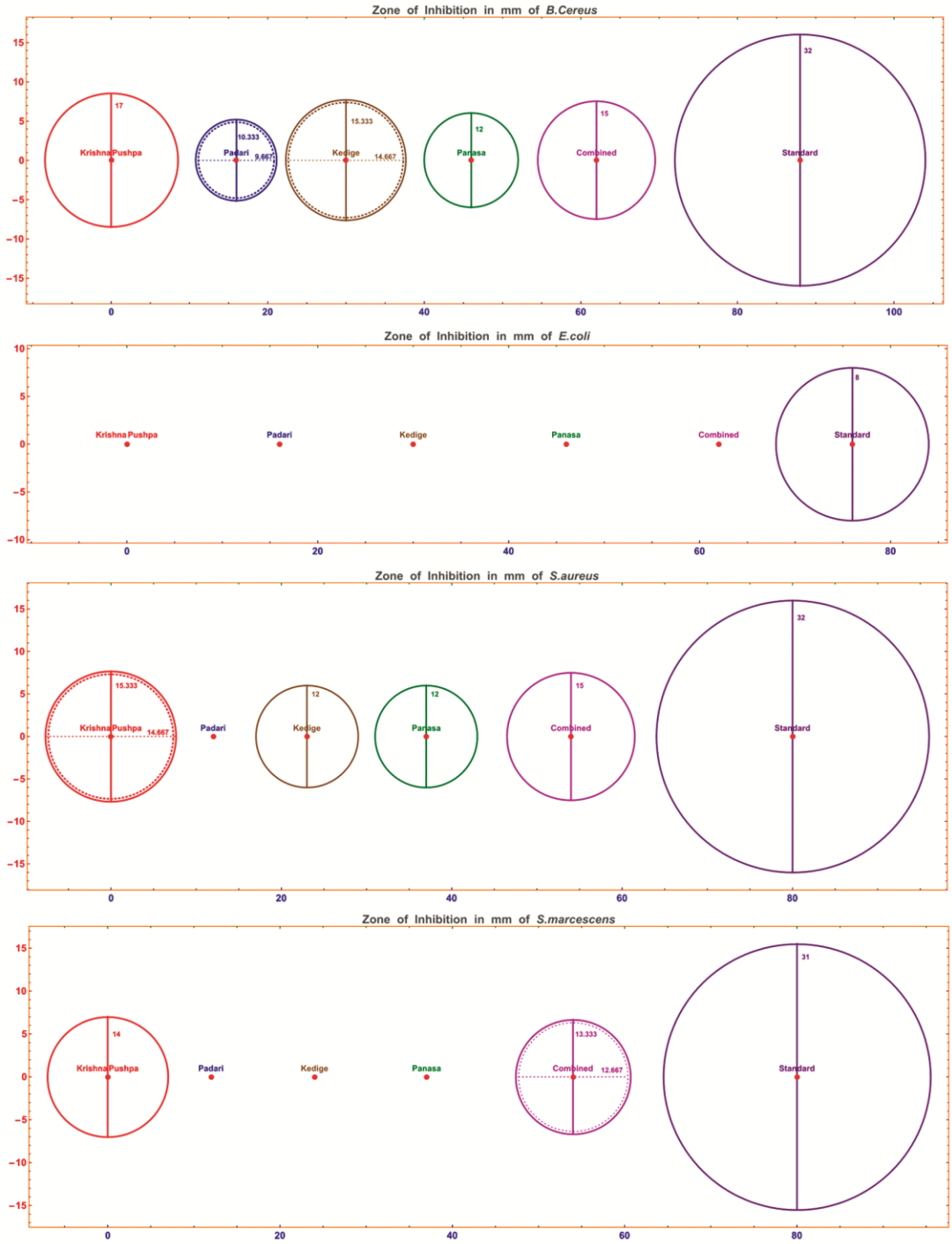

Fig. 4 — Plot depicting antibacterial activity of Panasa, Padari, Ketaki, Krishnapushpa and their combination

"Pushpayurveda", an ancient script arguably has been one of the key sources in the search of valuable natural products. Separate chapters have been dedicated to pharmacological aspects of flowers in "Bhavaprakasha Nigantu", classical texts of Ayurveda[26]. Similarly, therapeutic use of 67 medicinally important flowers has been described in "Siddha Vaidya"[27]. Further research in flower metabolomes will aid several traditional treatment systems to achieve status of rational and evidence based medicinal practices[25]. Deeper understanding of flower metabolomes will also complement modern techniques such as

reverse pharmacology, combinatorial chemistry and computational biology in developing smart drugs that promise health for all.

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Conflict of Interests

Authors declare no conflict of interest

Author Contributions

AP, GSN, SS, SS: Phytochemical evaluation, antimicrobial activity, antioxidant activity assay; Hamsapriye: Mathematical approach for analysis of the results**.**

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