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Vo. 46
Number 2
APRIL 2021

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Contents

Research Papers

Exploring Present Status of Home Science Graduates	Vatta, L., Chayal, K. And Tiwari, S.	53
Development of Yardstick of CV % for Maize Crop Experiments for Godhara Center	G.n. Motaka, X. U. Shukla And D.j. Parmar	58
Study of In *Vitro* digestion on antioxidant capacity of three different varieties of *Phoenix dactylifera*	R.v Sista And V.h Patel	63
Comparative analysis of physio-chemical parameters and effect of different juice extraction techniques on the pulp yield of nectarine cultivars	Shivani, Y.s Dhaliwal And Anita Kumari	70
Improving Blood Sugar Level of Non Insulin Dependent Diabetics with Indian Gooseberry Powder and Curcumin Powder	Priya Yadav And Ankita Gupta	78
In-vivo antiurolithiatic activity of *Thunbergia erecta*	V. Chandel, A. Choubey And S. Asati	84
Formulation and evaluation of transdermal patches of isolated compound from plant extract for in-vivo anti-inflammatory activity	S. Asati, V. Chandel, And A. Choubey	90
Serum Calcium and Phosphorus Levels In Relation to Age and Bone Health	R.bharathi	101
Price Dynamics of Tur in Major Markets of Karnataka.	Nataraj B.patted, Halaswamy D And K Vasudeva Naik	106

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Exploring Present Status of Home Science Graduates

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ABSTRACT

Home science is considered as a complete package which provides skills to manage home , develop entrepreneurship, startups and serving organizations related to subject. But nowadays the subject islosing its shine (matter of concern). To increase the interest and enrollment in it, a number of experiments were done (and still going on) including change in nomenclature and opening subject for boys . The present researchwas done with 424 students to explore the present professional status of Homescincegraduate students through a self-constructed tool which was administered via google forum. Results depictedthat 60% students are persuing further studies and 32% are either in job or self employed. Forty seven percent students admitted that they have faced challenges in getting job just because they were from home science and 43 % felt that their subject has no relationship with what they have studied in their college days.

Key words : Home Science, Community Science, Challenges, Job satisfaction, Working status

"There is no chance for the welfare of the world unless the condition of women is improved.

It is not possible for a bird to fly on only one wing."

Swami Vivekananda

To quote Swami Vivekananda, "Education is the process of bringing out and blossom the talent potential in human beings". 'Right to Education' as one of the fundamental right of every citizen in our nation that emphasizes its meaning in our development and improvement. Education sensitizes one to improve the quality of life. Higher education tackles mainly with the youth after schooling. It inspirestechnological know-how, improves the usefulness of the skills and promotes careerism along with a sense of liability and wealth. The other side of higher education handles with developing ethical character and scholar level of youngsters. Both quality of higher education and quantity of accurate skill are essential in building national spirit through its educated mentally healthyyoungsters. Home science is an applied and integrated science which aims at improving the quality of life for the individual.The family and the community precisely, the word Home Science can be interpreted as scientific and systematic education for organized home living which shall include the ever changing technological improvement and behavioral modifications of the members living in the home and influencing the community. Buildinga home and family was an art in India from centuries which hold a major place in the sixty four arts (chausth kala) according to which an individual had to master in it for successful living. Home Science in early the 20th century was not presented as a discipline but was more a subject of study. It was presented in selected schools aiming at preparing future homemakersfor noble families. Today Home Science is explained as a multipurpose curricular of study taken up by both boys and girls. Home science education has attained new magnitudes now. It takes care of individual's require and interests and develops abilities and capabilities for successful vocations, professions and careers in a global village. Therefore it has evolved as a vital tool for empowering women at household and community level as professionals in different capacities. The present study was conducted with an objective to explore the present professional status of Homescience Graduates.

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METHODOLOGY

The present research project was an ICAR funded extramural research project. The title of the project was to "Designing of Institute Industry Interface Program for Home Science Colleges of Rajasthan" granted for the financial Year 2018-19 and extended up 2019-2020. The project was grated to design the Institute Industry Interface mechanism for Home science subject and the present research paper is part of one of the objective ie to explore the present professional status of Home Science graduates.A tool was developed after an extensive review of researches, exploring a report of the previous project, and consultation with subject experts which was further evaluated by five teachers (teaching Home science subject) in the various universities. The tool was circulated through electronic mode (Google form) for convenient reach. The availed results were analyzed and presented inthe results section.

RESULTS AND DISCUSSION

Exploring present status was quite a challenging job due to three different type of degrees in which students get enrolled viz, B,A with Home science, B.Sc. in Home Science (three year form UGC recognized Institute and B.Sc. Home Science Vocational (Four Year from ICAR recognized Institute) which is having options for three type of post graduations. Highest students who are perusing a degree in home science are from B.A followed by B.Sc. three year and B.Sc. Four Year. So the acquired results are presented in the following sections-

I. Background information of the respondents

A total of 424 home science graduates was contacted. Background information includes, age, marital status, family type, years of attained graduation degree and the motivation source to opt homes science subject. It shows that most of the respondents belong to a very young category that is 20-25 of age followed by 26-30 year of age. Most of the respondents (59%) belongs to married category whereas 43% were unmarried, it gives a very strange picture as maximum respondents are from young age group (25 years) which is the age considered to be settled in careerwhereas according to data majority is married it indirectly shows that in India still the girls get married without completing their studies. Since maximum respondents were less than 25 years of age so most of the respondent category of less than 5 years of completion of their graduation.When the respondents were asked about the source of inspiration to choose home science as a subject, the maximum respondent (38%) have chosen home science because of their preferences. Whereas the data further shows that they were suggested by parents (30%). In present research it was observed that teachers played a good role in subject selection as 14 % students have taken this subject as they were inspired by their teacher and 7% enrolled in it because their friends were going in this field. Teachers again played a perfect role in shaping the career of the student and having an impression over students to opt the subject whichcan be seen as 14 percent students choose home science because they are inspired by their teachers, the students who were inspired from friends were less than 7 percent. An interesting fact that as most of the students have completed their graduation in five or ten years range, so we can see very less impact of social media(02%) as a source of motivation.

II. Present Status of home science graduate-

This section presents the information about the present status a home maker, study, job or business and issues with present status etc. covered under the following points-

II.a Present working status

II.b Issues associate with job due to having graduation from home science

II.c- Factors responsible/ motivated for attained present status

II.d- Interrelationship of home science and present status of respondents

Home Science/Community Science graduates are working on quite respective positions and have their entrepreneurship units. The subject is versatile so provides various opportunities for self-employment as well as jobs.

II.a Present working status – This section collects information on their present status which is categorized into four section viz homemaker, doing the study, working with some organization and holding own business and the results depicted in table-4

As depicted in table-1 overall 60 % of the respondents are studying (PG or Ph. D) at the time of data collection. Whereas a very good number of respondents(30%) are in job and a very few number (2%) are having their own business (run by themselves or their family business) whereas only

Table 1. Distribution of respondents by their Source working status N=424

Particular	Number	Percentage
Homemaker	34	8%
Study	252	60%
Job	129	30%
Business	09	2%

8% are homemakers. The data can be concluded that maximum respondents were married, pursuing study, it gives a strong message that nowadays families even in laws families are more oriented towards women education.

II.b Issues associate with job due to having graduation from home science-Only one third of respondents were in job and rest were in another phases of their life like study entrepreneurship and taking care of home. They were further asked about their struggle and issues they face in their journey to get a job (even if they are not in job) because of their degree in Home Science and the data presented in figure -1and table-2

The respondents were asked to respond in yes or no, if they have face any problem in getting a job because of the reason that they are being graduated from Home Science. More than fifty percent of them said that they didn't have any problem (as previous data clearly depicts that most of the respondents are in to their study phase, so they might haven't tried for job) whereas 47% accepted that they faced problems while exploring job. They were further asked to specify the kind of challenges which shows that most of them have face problems due to fewer job opportunities provided for home science students (45%), which is directly associated with low enrollment in the home science at graduation level.

Table-2 Distribution of respondents by their Issues associate with job due to having graduation from Home Science N=424

Particular	Number	Percentage	
Challenges faced while getting job as being home science graduate		200	47%
Type of challenges			
1.	less experience	140	33
2.	less practical exposure in graduation	82	19
3.	Poor communication skill	65	15
4.	Feeling inferior about yourself	48	11
5.	Not familiar with own potential needed to perform job	89	21
6.	No expertise in preparing resumes	58	14
7.	Society's negative mindset for Home Science	175	41
8.	Low job availability for Home Science students in other fields	192	45
9.	Others	57	13

Whereas,41% respondents admitted that society is having a negative mind set for the subject due to the prejudices by its name but it is affecting the confidence of home scientist followed by the issue less experiences(33%) before entering into the job market. Less experience might be a common reason faced by all graduates as they are fresh for professional tasks, so they face challenges while getting the job. Twenty one percent of respondents say that being dubious about the potentials regarding the kind of job/work a home sciencegraduate can do is the cause behind hesitation about self-performanceand less practical exposure (19%) were the major hurdles for them to get a job. Other challenges are poor communication skills (15%), no expertise in preparing resume (14%) and feeling inferior about themselves. Very few said that the subject is gender biased (8%), complexity in understanding the difference (5%) between B.A (Home Science) and B.sc(Home Science) and Less initiatives taken by the government to increase enrollment and employment (3%).

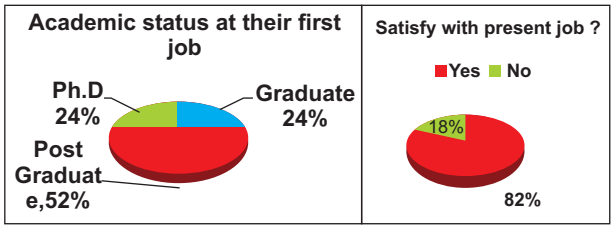
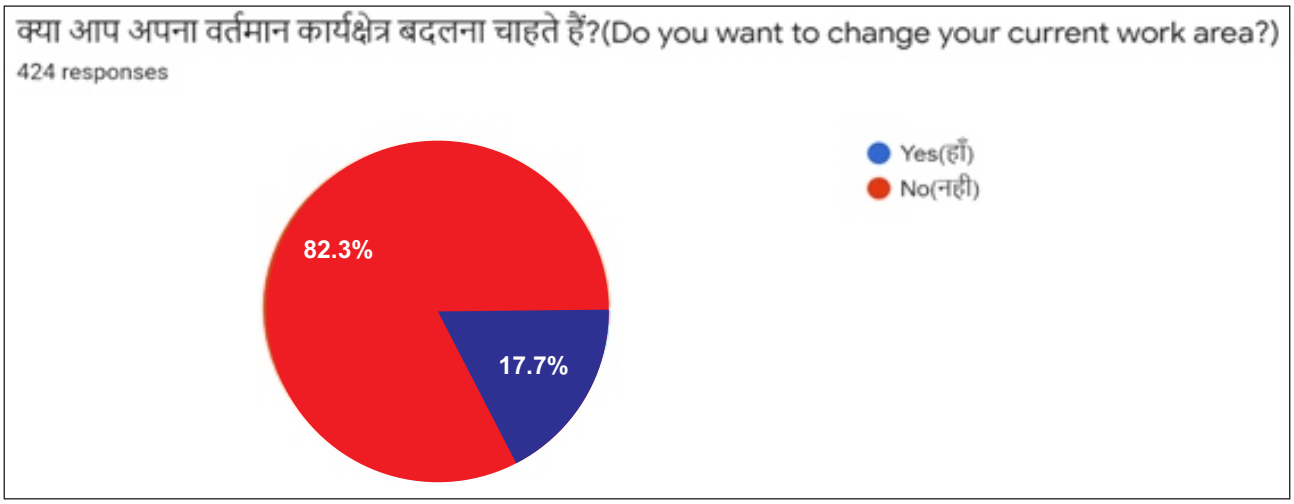


Figure- 1 Satisfaction with Jon and academic status at the time of the first job

The respondents were again asked to answer whether they are satisfied with their job or not? (figure-1), it is pleasing to know that 82% among the working population were satisfied with their job. In continuity, when they were requested to put some light on their wish to change their present work area (figure-2), the responses are absolutelysameas only 18 % of respondents want to change their present work area , which was similar to the number of unsatisfied (from present job) respondents. According to the Figure-1while describing their academic status (degree hold) at the time of their first job, it was found that maximum respondents (52%) get their first job after completing Post Graduation, as now days the trends are changing students feels that only after PG their study will be completed. The respondents who get their first job after Graduation and Ph.D were same (24% each category) in numbers, as the students who take a break in between UG and PG usually opt for B.Ed and this turned up as job provider in schools (after B.Ed.) Almost the same as of graduation (24%) were PhD and these are those people who are in research organizations and teaching. Most of them are working at various respective professions.



II.c- Factors responsible/ motivated for attained present status–In the previous section, the responses on the satisfaction (Yes/No) were discussed which were further explored to know the reason behind (motivation) satisfaction with present status and responsible factors behind not being satisfies with the present status. This section was open ended so the collected responses were categorized by the researcherbased on of similarity and presented in the table-3

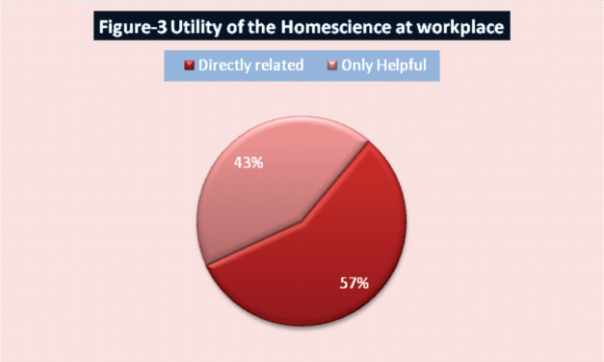
Table-3 Distribution of respondents based on of their response to factors responsible/ motivated for attained present status due to being Home Scientist

N=424

S.no.	Factors motivated	Percentage	Factors responsible for dissatisfaction	Percentage
1.	Home Science is a broad subject	87%	Lack of job opportunities related to Home Science	75%
2.	Home Science is a career oriented subject	85%	Negative mindset related to the subject	79%
3.	Home Science is a subject that deals with almost every field.	92%	Lack of institutions related to Home Science nearby Home	75%
4.	Home science is a subject that informs us about technology as well.	82%	Lack of Skill education	54%
5.	Home Science is a subject that imparts skills, knowledge and attitude.	93%	Subject is not included in civil and UPSC	61%

Nowadays employees satisfaction and motivation is a big challenge but in the present research it was found interesting that 82% of the respondents who were in job were satisfied with their present work status. It may be due to that home science is a subject which practicing life skills as a part of curriculum to the students that helps them to be happy and satisfied in the various phases of life. Motivated respondents pointed out thatit's a broad subject with career oriented approach, deals with almost every field and well versed with technological updates which overall imparts skills, knowledge and attitude. On the other hand lot of criticism was also observed which state that the subject lacks job opportunities, the negative mindset of society towards the subject, lack of institutions and skill education, Poor Economic Condition, no government initiative towards an update of the syllabus in government jobs.

II.d- Interrelationship of Home Science and present status of respondents - The subject a student read at their graduation level prepare them for their future. It can also be said it helps students to perform better in their work place. The respondents were asked to respond that" is there any relationship with their college education and present job?", received responses are presented in the figure -3



The results regarding the interrelationship of the Home Science and the present status of the respondents show that maximum respondent's work is directly (57%) related to Home Science and most of the respondent says that Home Science is only helpful in their day to day life.

CONCLUSION

The study was conducted to know the present professional status of Home science graduates and the findings revealed that majority of the students now a days go for Post-graduation or Ph.D which specifically indicates the shortage of job avenues available for youth. The findingswere from all the respondents of Home Science from various colleges' cities, districts and stateswhich can be used in developing a policy which is under process. It is recommended on the basis of findings that there is a need to have a strong Industry Institute Interface in Homescince at school or college level so that maximum number of student can identify the skill and plan accordingly after data collection. Informationon ground realities has come in picture and performance has taken in the form of policy making through which assistance, guidance and counselingmaybe provided to the Home Science graduates.

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Development of Yardstick of CV % for Maize Crop Experiments for Godhara Center

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ABSTRACT

The data on C.V. % for maize crop yield along with other details of 607 field experiments conducted during 2002-03 to 2016-2017 at Godhara center were collected and analyzed. The frequency distribution tables were prepared for various experimental factors. The upper fiducial limits (the yardstick) of C.V. % at 95% confidence based on non central't' distribution were worked out for accepting the results of maize crop experiments for Godhara center which emerged as 17 %.

Key words: CV%, Fiducial limit, Plot size, Non central t distribution, Experimental variability

INTODUCTION

Statistics is used to interpret data and sometimes to determine whether data are suspect. Most researchers are familiar with the use of the least significant difference (LSD) needed to separate two or more means. Another statistical measurement familiar to many scientists and taught in most basic statistics course is the coefficient of variation (CV). This familiar measurement was created in the late 1800s as a measure of variability. However, ever since it was tacitly promoted as a measure of experimental validity by (Snedecor and Cochran, 1967).Its original purpose has been largely ignored. The experimental data provide information on controlled (treatment effect) and uncontrolled variation. The uncontrolled variation is expressed as experimental error, which could be quantified as an estimate called 'coefficient of variation (CV)'. Besides, fertility variation among experimental units (plots), the factors contributing toward uncontrolled variation are climatic and experimental. Therefore, CV of field experiments varies with the situation. Lower magnitude of CV is the reflection of reliability (precision) of the experimental results. The acceptable range of CV advocated by various workers is based on the experience with very limited number of experiments. There is a need to develop a yardstick (critical value) for CV based on theory and also on a large number of experiments conducted under different situations and the present paper deals with this aspect.

Tyagi *et al*.1973 and Patel *et al*, 1978 pointed out that CV obtained for the crops under study was found to be considerably higher than those reported from the uniformity trials. They stated that the yardstick for accepting experimental results should be worked out using CV observed in the experiments rather than in the uniformity trials. Bajpai and Nigam, 1980 suggested a working rule for deciding the value of W2 (weight corresponds to precision of the experiment) and developed an index to evaluate agricultural field experiments statistically. Gomez and Gomez, 1984 reported that CV varies greatly with the type of experiment, the crop grown and the character measured. They opined that the acceptable range of CV is 6 to 8 % for varietal trials, 10 to 12 % for fertilizer trials and 13 to 15% for insecticidal and herbicidal trials on rice. Patel *et al* 2001, reported that the when the coefficient of variation in pulse experiments in randomize complete block design exceeds 23%, the experimental findings should not be considered for any purpose. Consequently, the CV has been used as a measure of validity for many types of agricultural experiments, from fertilizer experiments to crop performance trials. The CV was created as a measure of relative variability by Kendall and Stuart, 1977.

Cochran and Cox's, 1957 statement that “the coefficient of variation is often between 5% and 15%.” The basis for the CV is the assumption that the

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variance increases as the size of the mean increases. Allen et al., 1978 reported a positive relationship for several crops, and Gotoh and Osanai, 1959 reported a positive relationship for wheat. Masood and Javed, 2003 reported based on the coefficients of variation the optimum plot sizes for maize trials were estimated to be (14.06 m2) with square shape. Khan and Mead, 1998 presented uniformity data from field trials for improving precision of agriculture field experiments in Pakistan. Darji et al., 2010, developed the yardstick of CV % for forage crop experiment at 95 % confidence based on non central 't' distribution were worked out for accepting the results of forage crop experiments which emerged as 14%.

MATERIALS AND METHODS

The secondary yield character data of 607 experiments conducted on Maize crop at Godhara center during 2002-03 to 2016-2017. Information on plot size, number of treatments, replications, experimental design and disciplines was collected for each experiment.

The plot-wise yield data were subjected to statistical analysis and CV was estimated for individual experiments. The same was assumed as random variable in further analysis. CV is a function of square root of error mean square (*S*) and mean ($\dot{X}$.

$$CV = \frac{S}{R} = \sqrt{\frac{Error\ M.S.}{Mean}} \qquad (1)$$

The distributions of $\bar{X}$ and *S* have simple forms and Student's t distribution provides complete solution for testing the hypothesis or estimating fiducial limits relating to either or , singly. But t distributioncannot be used for $CV = \frac{S}{\bar{X}}$ Mckay, 1932 used non-central t-distribution for providing fiducial limits of CV.

Let z be a quantity distributed normally about zero mean with unit standard deviation and let w be a quantity distributed independently as $\chi^2/$ with *f* degree of freedom. Then, if *t* is defined by the equation:

$$t = \frac{Z+\delta}{\sqrt{W}} \qquad (2)$$

Where δ is some constant, then t is distributed in a manner depending only on δ and *f*. This distribution is a non central *t*-distribution. When δ equals zero, the distribution is the familiar Student's *t.*

Let an estimate of V be v = S/ $\bar{X}$

Now, one may write

$$\frac{\sqrt{n}}{v} = \frac{\sqrt{n}\bar{X}}{S} = \frac{\sqrt{n}(\bar{X}-\mu)}{\sigma} + \frac{\sqrt{n}\mu}{\sigma} / \frac{S}{\sigma} \qquad (3)$$

It appears from comparison with eq. (2) that $\frac{\sqrt{n}}{v}$ is distributed as non-central t with f = (n – 1) and $\frac{\sqrt{n}}{v}$

This distribution can be used for test of significance and for providing fiducial limits of V (i.e. CV), as is done for μ. Since the objective was to work out the yardstick based on CV, the upper fiducial limit of CV using non-central t-distribution was estimated following the procedure

given by (Johnson and Welch, 1939).

The procedure is briefly explained below. Let,

$$\text{(i) } CV = \frac{\sqrt{Error\ mean\ square}}{General\ mean}$$

n = number of treatments × number of replications in a given experiment,

f = *n* – 1 degrees of freedom.

Now, the upper fiducial limit of CV is,

$$CV_{UL} = \frac{\sqrt{n}}{\delta}(f, to\ \delta)$$

$$\text{Where, } t_0 = \frac{\sqrt{n}}{CV}$$

(ii) Find

$$Y = \left[1 + \frac{t_0^2}{2f}\right]^{-1/2}$$

Or

$$Y' = \frac{t_0}{\sqrt{2f}}\left[1 + \frac{t_0^2}{2f}\right]^{-1/2}$$

According to whether $\frac{t_0}{\sqrt{2f}}$ is greater than or less than 0.75. Consider *Y'*, if $\frac{t_0}{\sqrt{2f}}$ lies between – 0.75 and 0.75, otherwise consider *Y'*.

(iii) If $f > 9$, calculate $\frac{12}{\sqrt{f}}$

(iv) Select desired probability level of confidence, i.e. *e* and obtain $\lambda(f, t_0, \varepsilon)$ from the table in (Johnson and Welch, 1939) interpolating with respect to the quantities obtained in (ii) and (iii).

(v) Calculate

$$\delta(f, t_0, \varepsilon) = t_0 - \lambda\left[1 + \frac{t_0^2}{2f}\right]^{-1/2}$$

In the present investigation, the yardstick of CV for field experiments was worked out using two concepts: (i) average upper fiducial limit of CV for each of the 607 maize crop field experiments was worked out separately and then average of these upper fiducial limits was computed, and (ii) upper fiducial limit of CV based on average size of experiments, i. e. degree of freedom. The upper fiducial limit of 95 % and 90 % worked out using the theory of truncated t distribution as described by Johnson and Welch, 1939.

RESULTS AND DISCUSSION

The results presented in (Table 1) revealed that mean CV % and upper fiducial limits of average value of all the discipline except for agronomy and entomology discipline, were below the mean CV (11.74) %.

Table 1: Upper fiducial limit of CV % for different disciplines of Maize crop for Godhara center

Discipline	No. of	CV %	U L		Range		CV % > 16.45	
	expt.		(0.05)	(0.10)	(0.05)	(0.10)	No. of expt.	Proportion
Agronomy	183	13.23	22.23	18.14	9.00	4.91	33	0.18
Entomology	118	12.09	15.04	14.30	2.95	2.21	25	0.21
Pathology	24	10.47	13.48	12.71	3.01	2.24	4	0.16
Pl. breeding	282	10.74	13.53	12.83	2.80	2.10	44	0.15
Mean	607	11.74	16.45	14.71				

Table 2: Upper fiducial limit of CV % for different design of Maize crop for Godhara center

Design	No.of	CV %	U L		Range		CV % > 16.45	
	expt.		(0.05)	(0.10)	(0.05)	(0.10)	No. of expt.	Proportion
FRBD	24	14.81	19.29	18.11	4.49	3.31	5	0.20
RBD	530	11.39	16.31	14.44	4.92	3.05	86	0.16
Split Plot	53	13.83	16.52	15.88	2.70	2.05	15	0.28
Mean	607	11.74	16.45	14.71				

The design used in Maize crop experiments (Table 2) indicated that the higher upper fiducial limits and proportion of experiments (>16.45%) were observed for FRBD and Split plot design. RBD was within average fiducial limit and average proportion.

Table 3: Upper fiducial limit of CV % for different treatments of Maize crop for Godhara center

Treatments	No.of	CV %	U L		Range		CV % > 16.45	
	expt.		(0.05)	(0.10)	(0.05)	(0.10)	No. of expt.	Proportion
Up to 6	52	9.24	12.88	11.90	3.64	2.66	4	0.07
6-10	200	10.75	14.26	13.35	3.50	2.60	28	0.14
11-15	128	13.81	25.32	19.82	11.51	6.01	22	0.17
16-20	133	12.09	14.51	13.93	2.43	1.85	34	0.25
21-25	35	13.33	15.80	15.22	2.48	1.89	9	0.25
26-30	14	9.81	11.31	10.96	1.50	1.15	3	0.21
>30	45	11.48	12.86	12.55	1.38	1.07	6	0.13
Mean	607	11.74	16.45	14.71				

The results presented in (Table 3) revealed that experiments conducted with the set of treatments were within average fiducial limit of CV % except treatments range between 11-15, 16-20, 21-25.

Table 4: Upper fiducial limit of CV % for different plot size of Maize crop for Godhara center

Plot size	No.of	CV %	U L		Range		CV % > 16.45	
(m2)	experiment		(0.05)	(0.10)	(0.05)	(0.10)	No.of expt.	Proportion
<3	24	16.91	21.26	20.13	4.35	3.23	5	0.21
3-6	116	11.20	13.77	13.14	2.57	1.94	18	0.15
6-9	69	13.88	16.87	16.14	2.99	2.26	28	0.40
9-12	72	9.81	12.63	11.92	2.83	2.11	12	0.16
12-15	122	11.04	14.24	13.42	3.20	2.39	18	0.14
15-18	47	13.66	16.62	15.89	2.96	2.24	15	0.31
18-21	116	9.85	12.71	11.98	2.87	2.14	5	0.04
21-24	19	21.78	28.93	27.47	5.38	4.69	2	0.10
>24	22	9.72	12.29	11.63	2.57	1.91	3	0.13
Mean	607	11.74	16.45	14.71				

The results presented in (Table 4) revealed that mean CV % and upper fiducial limits were within limit of average value for all plot size except for <3, 6-9, 15-18 and 21-24 sq.m. sq.m. plot size. The upper fiducial limit, mean CV % and proportion of experiments for plot size 3-6, 9-12, 12-15, 18-21 and >24 sq.m. was less than average fiducial limit. Considering the proportion of experiments, plot size 9-15 sq.m. seems to be optimum plot size for maize crop experiments. However, it needs confirmation by plot technique study.

Table 5 : Upper fiducial limit of CV % for different replications of Maize crop for Godhara center

Replication	No. of expt.	CV %	UL		Range		No. of	Proportion
			(0.05)	(0.10)	(0.05)	(0.10)	expt.	
3	52	11.48	14.31	13.61	2.84	2.13	9	0.17
4	415	11.97	17.45	15.27	5.49	3.30	74	0.18
5	129	10.98	13.98	13.23	3.00	2.25	19	0.15
7	11	13.44	17.43	16.41	3.99	2.98	4	0.36
Mean	607	11.74	16.45	14.71				

The results presented in (Table 5) revealed that all experiments conducted with different number of replications were within average fiducial limit except with number of replications 4 and 7.

Table 6: The average upper fiducial limit and yardstick for CV % for the experiments of Maize crop for Godhara center

Name of Crop	No. of experiments	Mean CV %	Upper fiducial limit of CV %		Overall yardstick of CV%
			0.95	0.90	
Maize	607	11.74	16.45	14.71	17%

The average upper fiducial limit of CV % at 95 and 90 per cent confidence and average CV % of all 607 experiments were 16.45 %, 14.71 % and 11.74 % respectively (Table 6). The average upper fiducial limit of CV % (16.45 %) covers the region related to average CV % of all the experiments.

Table 7: Power of F-test as influence by CV%

Classes	No. of experiments	F-test		
CV%		Significant	Non-Significant	Ratio
1-5	66	65	01	0.02
5-10	232	217	15	0.07
10-15	167	129	38	0.29
15-20	92	71	21	0.30
20-25	35	25	10	0.40
25-30	7	6	1	0.17
> 30	8	4	4	1.00
Total	607	517	90	0.17

The ratio of number of experiments having non-significant to significant F-test was worked for each class of frequency distribution (Table 7). The results revealed that the ratio consistently increased with the increase in CV of the experiments. It also indicated that the efficiency (of detecting difference in treatment means) of F-test decreased with the increase in CV % of experiments. The average ratio was observed to be 0.17. The ratio for the class 10-15 % was almost equal to the average ratio. The class included 11.74 %, the mean CV % of all experiments. It can be seen from Table 7 that more than 15% of experiments having 17 % and more CV % failed to detect difference in treatments means. Results clearly showed that when the coefficient of variation in Maize crop experiments conducted in RBD exceeds 17 %, the experimental finding should not be considered for any purpose.

YARDSTICK OF C.V. % FOR MAIZE CROP EXPERIMENTS

The C.V. % data of 607 field experiments were used to fit non central 't' distribution and to work out upper fudicial limit of C.V. at 0.05 level of probability. According the upper fiducial limit of C.V. % at 95 percent confidence level of C.V. % was worked out to be 16.45 per cent. Thus, the results suggested that about 17 percent C.V. % should be considered as a yard stick for maize crop field experiments. These having C.V. % > 17 should be rejected for drawing scientific conclusion.

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Study of In *Vitro* digestion on antioxidant capacity of three different varieties of *Phoenix dactylifera*

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ABSTRACT

In this study red color dates developed by AAU, Anand using tissue culture technique was used and its antioxidant capacity was checked against yellow and red color dates available at local markets of Anand. The main aim of the study was to evaluate the antioxidant capacity of three different varieties of *Phoenix dactylifera* by conventional extraction and In *Vitro* gastrointestinal methods. The three different dates were procured, pre processed and later the samples were stored and then analyzed for total phenolics, flavonoid and total antioxidant capacity (FRAP, DPPH RSA, ABTS+ RSA) and Reducing Power assay. The red date developed by AAU, showed the highest total phenolics content when extracted using methanolic solvent. Further, the In *Vitro* gastrointestinal model proved that the antioxidant capacity of three different varieties of date fruit was reduced as flavonoid content was reduced as compared to conventional extraction methods. In conclusion, polyphenolic compounds were not completely degraded and made easy accessible in the In Vitro gastrointestinal model.

Keywords: *Phoenix dactylifera*, In *Vitro* gastrointestinal model, antioxidants, free radicals.

INTRODUCTION

Fruits are often ingested in many different ways like fresh, dried, frozen, canned and also as fruit juices (Ramulu, 2003). Mosele et al, 2015 reported that, 5-9 servings of fruits and vegetables per day as per U.S. Department of Agriculture tend to have the ability to lower the risks of many chronic diseases like cardiovascular diseases, cancer, metabolic syndromes, degenerative diseases, maintenance of optimal body function (Mosele et al, 2015). The above statements are evident because, fruits and vegetables contain natural phenol compounds like catechin, gallic acid, lutein, rutin, etc.

Phoenix dactylifera (date palm fruits) is also widely consumed like other fruits, all over the globe either in fresh state or dried state (Murugan et al, 2016).

Date palms are ancient plants cited from Vedas and Ramayana eras on this planet. They are generally rooted in Asia, Middle East, Africa and Arabian Peninsula (Nasir et al, 2015). This *P* dactylifera passes through several stages to be termed as a mature fruits (Fig.1) (Ghnimi et al, 2017).

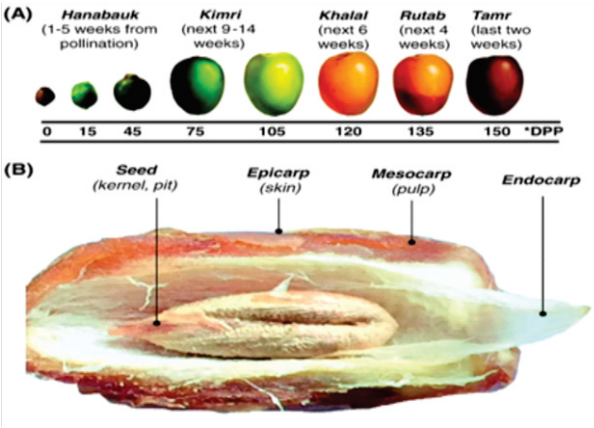


Fig.1 – Different fruiting stages of date.
Source – Ghnimi et al (2017) [5]

_ **Abbreviations:** GAE –gallic acid equivalents, RE – rutin equivalents, TAC – total phenolic content,TE-trolox equivalent

The date fruits are the richest source of carbohydrates, dietary fibers, essential vitamins and minerals. In addition to its dietary use, they also possess pharmacological benefits used to treat a variety of ailments in the various traditional systems of medicine. Phytochemicals analyzed by Baliga et al (2011) (Baliga *et al*, 2011), has revealed that the

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fruits contain anthocyanins, phenolics, sterols, carotenoids, procyanidine and flavonoid compound known to possess multiple beneficial effects.

In recent years, Anand Agricultural University (AAU), Anand Gujarat, has developed a new variety of red date fruit palm using a tissue culture technique which are sweeter than the variety grown in Kutch and now it is commercialized and farmers also started cultivating it. Recently these tissue culture date fruits are been sold in the markets of Anand. The sources report that tissue culture date fruits as well as date palm variety grown in Kutch are not subjected for the study of In Vitro gastrointestinal digestion for antioxidant capacity (Anonymous,2011) (Shah, 2014).

Digestion of food is an intricate procedure where, the complex food isbroken into simple form which gets assimilated into the blood. "In Vivo gastrointestinal digestion" means digestion within human body. The study of In VivoGI model is difficult hence; scientists have developed "In *Vitro* gastrointestinal model" which is a replica of human GI where, all the digestion processes are mimicked with the help of commercial enzymes, digestive juices and acids in controlled environment (Ulleberg *et al*, 2011).

In view of the above, the date palm fruits available in market which includes the yellow and red varieties of Anand local markets and tissue culture dates of AAU are not been studied for In *Vitro* digestion, hence the present study was planned.

MATERIALS AND METHODS

2.1 Preparation of sample

The red (V-1) and yellow (V-2) varieties of date fruit were procured from local market of Anand. The date fruit of tissue culture variety (V-3) were procured from AAU. Procured date fruit of all the three varieties were washed with tap water, air dried, separated from branches and weighted accurately, counted the number of fruits. Later the fruits were cut and seeds were separated, fruit pulp and seeds were weighted. Fruits were dried at 60°C for 2-3 days and stored at -20°C till the analysis.

2.2 Extraction of Samples

2.2.1 Extraction of sample by conventional method

A known amount of sample was taken and then it was extracted by using 80% methanol which was acidified to pH 2.0. The extracted samples were stored at -20°C in appendroff tubes, for further analysis to be carried out (Seerano et al, 2007) [10].

2.2.2 Extraction of sample by In Vitro gastrointestinal model (Bhatt and Patel, 2013)

Bhatt and Patel, 2013 gave the procedure of In Vitro gastrointestinal model, wherein a known amount of sample were taken and were subjected to enzymatic digestion like "In Vivo digestion." For enzymatic digestion, the samples were incubated in the following way –

Pepsin (0.6 ml of 300 mg/ml solution in a buffer of 0.2M HCl-KCl, pH – 1.5 at 40°C

⇩

Pancreatin(3 ml of 5 mg/ml solution in 0.1M Phosphate buffer, pH -7.5 at 37°C for 6 hours)

⇩

Lipase (6 ml of 7mg/ml solution in 0.1 M Phosphate buffer at 37°C for 6 hours)

⇩

Bile extracts porcine (6 ml of 17.5 mg/ml solution in 0.1M Phosphate buffer, pH-7.5 at 37°C for 6 hours)

⇩

α Amylase (3 ml of 120 mg/ml solution in 0.1M Tris Malate buffer pH-6.9 at 37°C for 16 hours)

Later the samples were centrifuged for 15min at 6000rpm's and then the supernatant was collected. Obtained residues were washed twice with the help of distilled water and then all the supernatants were pooled. The supernatant were incubated with 300µl of amyloglycosidase for 45min at 60°C. Then the volume was made up to known amount. For control, similar treatment was carried out, except addition of enzymes to the buffer.

2.3 Measurement of phenols by FolinCiocalteu Assay (Singleton *et al*, 1999)

Folin Ciocalteu method was used to determine total phenol content of the sample obtained from conventional method and In Vitro digestion model. A known sample aliquot was taken and volume was made up to 1 ml. 0.5 ml of FC reagent was added to the samples and were vertexed well and were incubated for 1 minutes at 37° C . Then 10 ml of 7.5% sodium carbonate was added and incubated at 37°C for up till 1 hour. A blue complex was developed which was read at 750 nm.Different aliquots of

known concentration of Gallic acid were taken as standard. For blank, standard and samples were not added and was treated like sample.

2.4 Estimation of Flavonoid (Zhishen *et al*, 1999)

Different aliquots of sample and standard rutin were taken and volume was made up to 5 ml with distilled water. 0.3 ml of 5% sodium nitrate was added and then incubated at 37°C. Later 0.6 ml of 10% aluminum chloride was added and mixture was incubated at 37°C for 6 minutes. Then 2 ml of 1N sodium hydroxide was added and 2.1 ml of distilled water was added. The pink color complex was obtained which was read at 510 nm.For blank, sample and standard were not added, and it was treated as sample.

2.5 Measurement of FRAP (Ferric reducing antioxidant power assay) (Benzie *et al*, 1999)

Different aliquots were taken and volume was made up to 300µl with distilled water. 1.8 ml of FRAP reagent was added and then incubated at 37°C for 10 minutes. The developed blue color was read at 593 nm, trolox was used as standard. For blank, sample and standard was not used, it was treated like sample.

2.6 Measurement of Reducing power assay (Oyaizu M, 1986)

Different aliquots were taken and mixed with 2.5 ml of 0.2M Phosphate buffer, pH 6.6 and 2.5 ml of 10% trichloroacetic acid was added to the mixture, which was then centrifuged at 3000rpm's for 10 minutes. 2.5 ml of the supernatant was taken and it was mixed with 2.5 ml of distilled water and 0.5 ml of 0.1% ferric chloride was added and the absorbance was measured at 700 nm. Different aliquots of Trolox were taken and treated as standard. For blank, sample and standard were not taken, and it was treated like sample.

2.7 Estimation of ABTS radical scavenging assay (Huang *et al*, 2005)

The ABTS radical cation [2,2Azinobis (3-ethyl benzothiazolin-6-sulfonic acid) diammonium salt] were generated by reacting ABTS and potassium persulfate after incubation at room temperature in the dark for 16 hours. The solution of ABTS was diluted with ethanol to an absorbance of 0.7 at 734 nm. A known sample aliquot was taken and volume was made up to 1 ml with ethanol. Later 1 ml of ABTS reagent was added and the content was vertexed for 10 seconds. The resultant oxidized mixture was measured at 734 nm and was compared with standard trolox. The blank was performed like sample, without standard and sample aliquot.

2.8 Estimation of DPPH radical scavenging (Brand Wiliams *et al*, 1995)

The antioxidant activity of the extract, on the basis of the scavenging activity of 2,2-diphenyl -1- picryl-hydrazyly (DPPH) free radical were determined of the samples. 3 ml of DPPH of optical density 1 at 513 nm in methanol was added to different aliquots of sample after making up to the volume 1 ml with methanol. The absorbance was measured at 517nm after incubation at 37°C for 20 minutes. For standard, trolox was used, and was treated like sample. The blank was carried out same like sample, without standard and sample.

Statistical Analysis

All the analysis were done in duplicates of each sample and are presented as Mean ± S.D by using ANOVA with two way analysis with replication (MS Excel) and SPSS version:20.

RESULTS AND DISCUSSION

The present study was carried out on the “Effect of In *Vitro* digestion on antioxidant capacity of fresh date fruits, procured from local markets (V-1 and V-2) and tissue culture variety (V-3) from Anand Agricultural University. To understand the results, the samples are given the codes as follows –

- S-1:- conventional extracted samples
- S-2:- control samples without addition of digestive enzymes
- S-3:- samples after gastric digestion
- S-4:- samples obtained after small intestinal digestion.

3.1 Total Phenols

The total phenolics content was found highest in V-3. It was lowest in V-2. The different varieties of date fruit have shown a significant ($P \leq 0.05$) effect on the total phenolics content in conventional extract as well as In Vitro digested samples. The total phenolics content was significantly ($P \leq 0.05$) effected by the extraction methods that are conventional extract and In Vitroextracts. The interaction between different varieties of date fruit and methods of extraction didn't show any significant effect on the total phenolics content of date fruits. The ranking of the phenolics content of the date fruits is V-3 > V-1 > V-2 as shown in the Table-1.

3.2 Flavonoid Content

The flavonoid content was found highest in V-3. It was found lowest in V-2. The different varieties of date fruit have shown a significant ($P \leq 0.05$) effect

on the flavonoid content in conventional extract as well as In Vitro digested samples. The flavonoid content was significantly (P ≤ 0.05) effected by the extraction methods that are conventional extract and In Vitro. The ranking of the flavonoid content of date fruits is V-3 > V-1 > V-2 as shown in Table -2.

3.3 Total Antioxidant Capacity

3.3.1 FRAP (Ferric reducing antioxidant power)

The FRAP was found highest in V-3. It was lowest in V-2. The different varieties of date fruits has shown a significant (P ≤ 0.05) effect on the FRAP in conventional extract as well as In Vitro digested samples. The FRAP was significantly (P ≤ 0.05) effected by the extraction methods that are conventional extracts and In Vitro. The interaction between variety of date fruit and methods of extraction didn't show any significant effect on FRAP of date fruits. The ranking of the FRAP of the date fruits is V-3 > V-1 > V-2 as shown in Table – 3.

3.3.2 DPPH Radical Scavenging Assay (DPPH)

DPPH radical scavenging ability was highest in V-3. The V-2 variety showed the lowest activity. The different varieties of date fruit has shown significant (P ≤ 0.05) effect on the DPPH RSA through conventional extract and In Vitrodigested samples. The DPPH RSA was significantly (P ≤ 0.05) effected by the extraction methods that are conventional extracts and In Vitroextracts. The ranking of the DPPH RSA of the date fruits is V-3 > V-1> V-2 as shown in Table -4.

3.3.3 ABTS+ Radical Scavenging Activity (ABTS+ RSA)

The ABTS+ RSA was highest in V-3. The V-1 variety showed the lowest ability to scavenge ABTS+ radicals. The different varieties of date fruits had shown significant (P ≤ 0.05) effect onthe ABTS+ RSA through conventional extracts and In Vitro digested samples. The ABTS+ RSA was significantly (P ≤ 0.05) effected by the extraction methods that are conventional extracts and In Vitro. The interaction betweenvarieties of date fruits and methods of extraction didn't show any significant effect on ABTS+RSA. The ranking is V-1 < V-2 < V-3 as shown in Table – 5.

3.4 Reducing Power Assay (RPA)

The RPA was found highest in V-3. The V-2 variety showed the lowest. The different variety of date fruits has shown a significant (P ≤ 0.05) effect on reducing power in conventional and In Vitro extracts. After In Vitro digestion V-1 showed the lowest and V-2 showed highest reducing power. The interaction between three different varieties of date fruit and methods of extraction didn't show any significant effecton the reducing power. The ranking for reducing power is V-2 < V-1 < V-3 as shown in Table – 6.

Fresh dates are rich in polyphenols like benzoic acids and cinnamicacidswhich possess antioxidant properties that have a significant role in biological system.Murugan et al (2016) reported in his study that after small intestinal digestion of date fruit there is an increase in catechin and quercetin polyphenols contents and p-Coumaric acid and ferulic acid were undetectable [3]. Studies also stated that methanolic extract had higher polyphenolics content rather than obtained after small intestinal digestion.

Table 1 : The Total Phenolics content of conventional extract and In Vitrodigested extracts of three different varieties of date fruits (mgGAE/100 gm extracts).

Samples	Extraction Method				
	S-S-1-1	S-2S-2	SS-3-3	S-4	F-Value
V-1	690.5 ± 17.2	458.1 ± 52.6	459.3 ± 27.9	1468.0 ± 24.2	1820.55*
V-2	360.9 ± 28.7	254.3 ± 16.2	487.4 ± 12.7	1053.4 ± 32.	
V-3	1009.4 ± 60.0	336 ± 43.84	495.8 ± 18.1	1337.2 ± 30.5	
F-Value			280.34*		
Interaction					96.33

- Values are Mean ± S.D of four observations
- *Indicates a significant difference at P ≤ 0.05

Table : 2 The Flavonoid content of conventional extract and In Vitro digested extracts of three different varieties of date fruits (mgRE/100 gm extracts).

Samples	Extraction Methods				
	S-1	S-2	S-3	S-4	F-Value
V-1	466.4 ±34.1	189.8 ± 6.9	181.5 ±44.0	305.4 ± 37.4	432.25*
V-2	235.4 ±24.0	106.0 ± 11.9	106.5 ±10.9	223.6 ± 47.3	
V-3	867.4 ± 24.0	123.4 ± 17.8	156.6 ±10.7	235.1 ± 23.7	
F-Value			147.21*		112.4

- Values are Mean ± S.D of four observations
- *Indicates a significant difference at P ≤ 0.05.

Table : 3 The Ferric Reducing Antioxidant Power of conventional extract and In *Vitro* digested extracts of three different varieties of date fruits (mgTAC/100gm extracts).

Samples	Extraction Methods				
	S-1	S-2	S-3	S-4	F-value
V-1	1077.1 ± 197.9	415.6 ± 80.3	352.2 ± 137.1	1821.9 ± 168.5	257.64*
V-2	648.2 ± 36.9	261.2 ± 23.5	311.3 ± 76.7	1445.7 ± 69.21	
V-3	1822.7 ± 126.1	310.3 ± 87.9	473.7 ± 76.7	353.5 ± 20.3	
F-value	24.04*				
Interaction					106.94

- Values are Mean ± S.D of four observations
- *Indicates a significant difference P ≤ 0.05.

Table : 4 The DPPH RSA of conventional extract and In Vitrodigested extracts of three different varieties of date fruits (mgTE/100 gm extracts).

Sample	Extraction Methods				
	S-1	S-2	S-3	S-4	F-value
V-1	227.6 ± 31.6	61.5 ± 4.2	89.9 ± 7.1	197.3 ± 13.3	323.11*
V-2	128.5 ± 16.5	64.7 ± 7.0	90.7 ± 5.6	142.0 ± 14.9	
V-3	307.2 ± 8.5	44.4 ± 4.8	117.7 ± 4.6	175.3 ± 21.1	
F-Value		62.84*			40.36

- Values are Mean ± S.D of four observations
- * Indicates a significant difference at P ≤ 0.05

Table : 5 The ABTS+RSA of conventional extract and In Vitrodigested extracts of three different varieties of date fruits (mgTE/100 gm extracts)

Sample	Extraction Methods				
	S-1	S-2	S-3	S-4	F-value
V-1	90.0 ± 6.0	249.5 ± 10.9	141.9 ± 2.6	195.7 ± 14.3	216.93*
V-2	155.2 ± 41.4	450.8 ± 31.6	122.3 ± 10.1	325.0 ± 42.9	
V-3	193.1 ± 51.5	407.2 ± 37.5	137.3 ± 0.4	398.7 ± 3.0	
F-Value		78.89*			16.91

- Values are Mean ± S.D of four observations
- * Indicates a significant difference at P ≤ 0.05.

Table : 6 The Reducing Power Assay of conventional extract and In Vitrodigested extracts of three different varieties of date fruits (mgTE/100 gm extracts).

Sample	Extraction Methods				
	S-1	S-2	S-3	S-4	F-value
V-1	1844.1 ± 106.1	1651.1 ± 409.3	1266.9 ± 134.7	1493.1 ± 153.1	44.33*
V-2	1140.3 ± 94.9	1079.2 ± 119.1	1092.3 ± 39.7	1687.3 ± 137.9	
V-3	2011.6 ± 155.4	1152.9 ± 40.6	854.7 ± 110.7	1682.72 ± 141.3	
F-Value			18.47*		16.56
Interaction					

- Values are Mean ± S.D of four observations
- * Indicates a significant difference at P ≤ 0.05.

The possible reason for the decrease of polyphenolicsIn Vivo after small intestinal digestion is, the phenolics activity with other dietary constituents released during digestion, such as iron, other minerals, dietary fiber or proteins may be present which are known to impair polyphenols solubility andbioavailability (Chen *et al*, 2016) the possible reason for the decrease in phenolics after small intestinal digestionafter In Vitro digestion is difficult to justify (Chen et al, 2016).

The results of the present study indicated that there is a significant decrease in the bioavailability of flavonoids, the possible reason for In Vivo may be, due to the decreased absorption through gut barrier, and excreted through bile or metabolized by the colonic microflora of our own body tissues. Several other factors are also known to affect the quantity of polyphenols profile; one of the major factors is the geographical origin as well as the degree of ripeness of the fruit which also contribute to the presence of flavonoids content (Vinha et al, 2005) (Scalbert and Williamson, 2000). Kosinska-Cagnazzo *et al* (2015)reported that during In Vitro digestion of fruits containing anthocyanins pigment (V-1 and V-3), when subjected with pepsin during gastric digestion, it showed no significant effect on the total anthocyanins content but, during small intestinal digestion, there was a significant decrease; this may be possible due to the alkaline medium where, anthocyanins lose their stability (Kosi?ska-Cagnazzo *et al*, 2015).

The result of the present study showed that antioxidants present in three different varieties of date fruit may have been destroyed, inhibited, transformed or otherwise far less available during the intestinal phase of digestion.

CONCLUSION

From the results obtained for various biochemical parameters for "Effect of InVitro digestion on antioxidant capacity of three different varieties of Phoenixdactylifera" it is concluded that bioavailability of dietary polyphenolicsafter subjecting to gastrointestinal digestion was easy. The red date fruit developed using tissue culture technique (V-3) showed the highest total phenolics content when extracted using methanolic solvent. Further, the In Vitro gastrointestinal model proved that the antioxidant capacity of three different varieties of date fruit was reduced, as flavonoids content was reduced as compared to conventional extraction method.

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Comparative analysis of physio-chemical parameters and effect of different juice extraction techniques on the pulp yield of nectarine cultivars

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ABSTRACT

Fruits supplement human diet by providing various nutrients. Fruit cultivation in India, grows most fruitful in the areas of the Himalayas, with abundance from every angle. Nectarine fruit is a hybrid of peach and plum. The major commercial varieties of nectarine grown in Himachal Pradesh are May Fire, Snow Queen and Silver King. The study was aimed to determine the difference in nutritional parameters of selected cultivars of nectarine and to study the effect of different juice extraction techniques on the yield of pulp. Results revealed that there was a non-significant difference in terms of physical parameters in all the varieties. In case of proximate composition significant difference was observed in ash and carbohydrate content among all the varieties. pH , ascorbic acid, brix-acid ratio and sugars had significant difference with highest ascorbic acid was noted in May Fire (8.52mg/100gm) while Snow Queen variety had highest pH (3.30) and total sugars (8.33 %) when compared with each other. Mineral composition showed that the fruit had highest content of potassium with maximum value reported for Snow Queen (202.00 mg/100g). A significant difference was also observed in all the varieties when analyzed for phosphorous, magnesium and sodium content. Data related to juice extraction techniques showed that highest pulp recovery was observed in blanching treatment with pulp recovery noted as 70, 69 and 68 per cent for Snow Queen, May Fire and Silver King while lowest pulp recovery was noted in manual method.

Key Words: nectarine, cultivars, physico-chemical parameters, extraction techniques

INTRODUCTION

Deciduous fruits, covering pome and stone fruits contribute importantly to the horticultural economy of India. Since long back, India has served as a country dependent on agriculture. A large number of fruit and vegetable are grown in different parts of the country. Nature has been abundantly generous to Himachal Pradesh in endowing it with conditions conducive for growing of large variety of fruits that is why Himachal Pradesh is known as 'Fruit bowl of India'. Nectarine fruit is a hybrid of peach and plum. In India, Himachal Pradesh is a state which has made efforts for growing nectarine fruit by Horticulture Department in Palampur area of Kangra district. About 28 thousand ha area is covered under peach, plum, apricot, almond and cherry and estimated yield of peach and nectarine is 0.50 t/ha in Himachal Pradesh (Ghosh, 2010). The major commercial varieties of nectarine grown in Himachal Pradesh are May Fire, Snow Queen and Silver King. Fruit quality is a fundamental determinant for the acceptance of nectarine cultivars by consumers, because of the high competition of new released cultivars in the market (Crisosto and Crisosto 2005). Nectarines are characterized by yellow or white flesh, freestones, round shape, red peel, resistance to handling and shipping and high soluble solid content (Sortino *et al.,* 2013).

Nectarines (*Prunus persica*) belong to the Rosaceae family and are thought to have originated in China. Nectarine fruit is having a fuzzless skin. Nectarine fruit look more like plums than peaches because of the smooth and shiny skin that's why nectarine is also known as “Peach with a plum skin”. The major difference between the nectarine and peach is that the nectarine has smooth skin and the peach has needle-like, hairy or fuzzy skin. In the present scenario, everybody is acquainted with the term 'Superfruits', which provide the significant value of nutrients beyond basic nutrition, as having high antioxidants, nutrient density and with potential health benefits such as the ability to lower certain risk of diseases (Palmer, 2009). Nectarines have a lower calorie count and are a good source of carotenes, flavonoids, potassium, phosphorus, dietary fiber,

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and vitamins A, C, lycopene and lutein. By considering nectarine as super fruit, the study was planned to find the difference in selected cultivars in terms of nutritional composition and to determine the effect of different juice extraction techniques on the percent juice/pulp yield of selected nectarine cultivars.

MATERIALS AND METHODS

The study was carried out in the year 2009-2011 at CSKHPKV, Palampur (H.P) in the Department of Food Science, Nutrition and Technology, CSKHPKP, Palampur (Himachal Pradesh), India. Three varieties of nectarine fruit viz. Snow Queen, May Fire and Silver King were procured from the Horticulture Department, CSKHPKV, Palampur (H.P), India. The fruits were washed under running tap water to remove adhering dirt etc. The three varieties of fruits were assessed for physical, chemical, proximate composition, mineral estimation and juice extraction techniques.

Physical parameters:

Fruit colour and shape: It was assessed by visual appearance while length and breadth of the fruits were assessed by vernier caliper.

Fruit volume: It was recorded by water displacement method in which 500 ml of measuring cylinder was taken and filled with 200 ml of water. 50g of fruit was put into the cylinder. The raise in water level was noted and recorded in ml.

Specific gravity: It was calculated by dividing the weight of ten randomly selected fruits by volume of ten randomly selected fruits.

$$\text{Specific gravity (g/ml)} = \frac{\text{Weight of fruits (g)}}{\text{Volume of fruits (ml)}} \times 100$$

Weight : The fruit weight was assessed by electronic weighing balance.

Chemical parameters:

TSS and pH content : TSS and pH content was measured by hand refractometer and pH meter, respectively.

Moisture, protein, fat, ash and fibre: These parameters were estimated by the method (AOAC, 1990).

Carbohydrates : Carbohydrates were determined by the method NIN, 1983.

Total carbohydrates (%) = 100- (moisture %+ protein %+ fat % + fibre % + ash %)

Acidity, ascorbic acid, pectin, sugars and minerals: These parameters were estimated by the approved methods of Ranganna (2007).

β–carotene (Srivastava and Kumar, 2003)

β-carotene was extracted from the sample by crushing 5 g of sample with 10-15 ml acetone, adding crystals of anhydrous sodium sulphate. The supernatant was decanted and collected in a beaker. The process was repeated twice. 10-15 ml petroleum ether was added and mixed thoroughly. The content was transferred in to the separating funnel, two layers were separated out on standing solution. Lower layer was discarded and upper layer was collected and volume was made upto 100 ml with petroleum ether. The optical density was recorded at 452 nm using petroleum ether as blank.

$$\text{β-carotene (mg/100g)} = \frac{\text{O.D} \times 13.9 \times 10^4 \times 100}{\text{Wt. of sample (g)} \times 560 \times 1000}$$

Anthocyanin (Srivastava and Kumar, 2003)

Anthocyanin was extracted from the sample by blending 10 g of sample with 10 ml of ethanolic HCL and transferred to 100 ml volumetric flask. The volume was made up and the solution was stored in refrigerator at 4°C, and then filtered through Whatman No.1 filter paper. Optical density of filtrate was recorded at 535 nm.

$$\text{Total O.D /100 g} = \frac{\text{O.D x Volume made up x 100}}{\text{Weight of sample (g)}}$$

$$\text{Total anthocyanin (mg/ 100g)} = \frac{\text{Total O.D / 100 g}}{98.2}$$

Standardization of juice extraction techniques:

Different techniques for peeling and softening of fruit tissues were done for the maximum recovery of pulp/ juice. Peeling techniques were standardized in the laboratory with 100g of fruits/ treatment. The peel, pulp and stone percentage were recorded. The methods for different extraction techniques were illustrated as:

Manual peeling

Fruits of three varieties of nectarine were sorted and washed properly. The peel and pulp were extracted manually and recorded its percentage.

Blanching

The fruits were blanched in boiling water for 3 to 5 minutes and immediately transferred to cold water. Peel the skin and pulp was extracted. The recovery of pulp was noted.

Hot lye peeling

The fruits were tied in a muslin cloth and treated with different concentration of lye solution i.e. 1, 2, 3 and 4 % lye solution (NaOH) at 80˚C for appropriate time to remove the peel properly. 4 % lye solution at 80 C for 120 seconds was found to be the best treatment. After treatment the fruits were dipped in cold water followed by dipping in 1 % citric acid solution to remove excess of lye and finally the fruits were rinsed in water. Pulp was extracted, homogenized and measured the peel, stone and pulp recovery.

Cold lye peeling

Fruits were tied in a muslin cloth and treated with different concentration of lye solution i.e. 1, 2, 3 and 4 % lye solution (NaOH) for appropriate time to remove the peel properly. 4 % lye solution for 8 to 10 minutes was found to be best. After treatment the fruits were dipped in cold water followed by dipping in 1 % citric acid solution to remove excess of lye and finally the fruits were rinsed in water. Pulp was extracted and quantity was measured.

Steaming

The fruits were subjected to steaming for 5, 7, 9 and 11 minutes in autoclave by adding known amount of water. Steaming for 7 minutes in autoclave was found to be best for peel removal and pulp extraction. Pulp was extracted and recovery was noted.

RESULTS AND DISCUSSION

Physical characteristics

Table 1 shows data related to physical parameters. Figure 1 represents fruit colour as reddish yellow with round shape. The mean values for length, breadth and weight for all the cultivars were ranged from (3.97- 4.07cm), (4.16-4.30cm) and (40.10-41.40 gm). Studies by (Milosenic *et al.,* 2012; Kishore *et al.,* 2017) reported weight for Mayfire cultivar and Red Nectarine as 66.77 g and 147.56g which is higher than the cultivar selected. While the results for length and diameter is also on the higher side (Milosenic *et al.,* 2012; Kishor *et al.,* 2017). The results for the values for fruit volume (ml) and specific gravity (g/ml) ranged from 40.00-41.04 (g/ml) and 1.-1.02 (ml), respectively. All the cultivars varied non - significantly with respect to physical parameters. The results for specific gravity are in close agreement with the findings (Kishor *et al.,* 2017).

Proximate composition

The mean values for moisture and protein content were ranged from 85.75 to 85.93 and 1.22 to 1.32 %, respectively (Table 2). A non-significant difference (P≤0.05) was observed when all the cultivars were compared with each other. The per cent moisture and protein content present in four varieties of nectarine varied from 86.20 to 88.40 and 0.80 to 1.10 %, respectively (Wills *et al.,* 1983). The values are in close agreement with the present results. This variation would be due to genetic variation of the varieties. The values for crude fat ranged from 0.44 to 0.50 per cent. (*Wills et al.,* 1983) reported the value of % fat present in four varieties of nectarine was 0.10 %. The values for ash were calculated as 0.73, 0.67 and 0.80 per cent for Snow Queen, May Fire and Silver King, respectively. The % ash present in four varieties of nectarine varied from 0.30 to 0.40 per cent (Wills *et al.,* 1983). As per the data, the values for crude fibre varied non-significantly within the varieties. The values of crude fibre for Snow Queen, May Fire and Silver King were calculated as 2.05, 1.98 and 2.00 %, respectively. Data regarding carbohydrate content reveals that all the three varieties of nectarine fruit differed significantly (P≤0.05) and the values ranged from 11.64 to 11.91 per cent. This variation in the values might be due to the varietal difference and the stage of maturity.

Chemical Composition and functional constituents

Table 3 illustrates data pertaining to total soluble solids, pH, acidity, ascorbic acid, brix-acid ratio, sugars, pectin, β- carotene and total anthocyanin of three varieties of nectarine fruit. The values for TSS differed non-significantly with the varieties as the recorded values ranged from 10.5 to 10.7 ˚B. The results of the present study are in agreement with the findings of (Wills *et al.,* 1983; Kishore *et al.,* 2017; Farina *et al.,* 2019). The pH values of three varieties of nectarine varied significantly (P≤0.05). The pH values of three varieties of nectarine were calculated as 3.30, 3.23 and 3.20. The variation may be due to varietal difference and stage of maturity and harvesting. The results obtained are in close agreement with (Srivastava and Arora 1996 and Joshi *et al.,* 1991). The values for acidity in three varieties were calculated as 0.85, 0.76 and 0.89 % as malic acid. The storage behavior of Sunred nectarine fruit recorded the titrable acidity as 0.84 per cent (Dhillon *et al.*, 1981). According to (Srivastava and Arora 1994; Kumar 1991; 1995), the titrable acidity values varied from 0.37 to 1.01, 0.78 to 0.91 and 0.36 to 0.98 %, respectively. The values for acidity are in agreement to the cited ones. The value of ascorbic acid content of three varieties of nectarine fruit viz. Snow Queen, May Fire and Silver King were 7.56, 8.52 and 8.03 mg/100g, respectively. The results for ascorbic acid are in line with the investigation of (Barwal and Sharma 2001; Sharma 2002; Kishore *et al.,* 2017). Brix-acid ratio is an important parameter to determine the optimum

fruit maturity. As per the data the values varied significantly among the varieties. Almost similar observations were recorded by (Sharma and Lal 1999; Kher and Dorjay, 2001). The values of reducing sugars varied non-significantly with respect to varieties, as the highest value was observed in Silver King (5.98 %) followed by Silver King (5.97 %) and May Fire (5.97 %). Values of present study are in close agreement with the finding (Mohapatra and Sharma, 1997). The values for non-reducing sugars varied significantly with the varieties. Maximum value of non-reducing sugars was recorded in Snow Queen (2.37 %) followed by May Fire (2.11 %) and Silver King (1.93 %). Total sugars varied significantly with respect to varieties and the values for total sugars were calculated as 8.33, 8.19 and 8.02 % for three verities of nectarine. The difference in values may be due to varietal difference. The present results are in line with the findings (Srivastava and Arora 1994; Mohapatra and Sharma 1997; Gothwal *et al.,* 1998; Sharma and Lal, 1999). The data regarding the pectin content of three varieties of nectarine fruit varied non-significantly among the varieties. Maximum value for pectin was observed in Silver King (0.91 %) followed by May Fire (0.88 %) and Snow Queen (0.85 %) as calcium pectate. The present findings are in close agreement with the findings (Wani and Saini, 1990). The values for β-carotene were differed non-significantly with the varieties and the values calculated for β-carotene for three varieties of nectarine fruit were 1.16, 1.15 and 1.29 mg/100g. The present results are in accordance with the results (Mariaa *et al.,* 2002). The values for total anthocyanin content of three varieties of nectarine fruit varied non-significantly.

Mineral Composition

The data in Table 4 shows mineral composition. Calcium, phosphorus, magnesium, sodium, potassium, iron and copper were analyzed in three varieties of nectarine fruit. The values for calcium varied non-significantly with the varieties viz. Snow Queen (6.00), May Fire (5.80) and Silver King (6.00) mg/100g. However, phosphorus content varied significantly among the varieties. Magnesium content of three varieties of nectarine varied significantly with the varieties viz. Snow Queen (8.87), May Fire (9.00) and Silver King (8.50) mg/100g. Sodium content differed significantly among the varieties and it was estimated as 0.22, 0.18 and 0.25 mg/100g in three varieties. Potassium content of three varieties of nectarine fruit varied significantly with the varieties and the highest value was recorded in Snow Queen (202.00), followed by Silver King (200.89) and May Fire (200.80) mg/100g. However, the values for iron and copper varied non-significantly ($P \leq 0.05$) within the varieties. The estimated values for iron and copper ranged from 0.25 to 0.29 and 0.06 to 0.09 mg/100g, respectively. The difference in the mean values could be due to varietal and agro-climatic reasons. (Wills *et al.,* 1983) scrutinized the values of different minerals viz. K, Na, Ca, Mg, Fe and Zn and the values ranged between 220 to 240, 0 to 1, 6 to 11, 6 to 8, 0.1 to 0.2 and 0.1 mg/100g, respectively. The slight difference could be due to varietal difference and agro-climatic reasons.

Standardization of peel and pulp extraction techniques:

Data pertaining to effect of different pulp extraction techniques on the pulp, peel and stone recovery of nectarine fruit are presented in Table 5. Highest pulp recovery was observed in 'Blanching treatment' as the values for per cent pulp recovery were observed as 70, 69 and 68 % for Snow Queen, May Fire and Silver King, respectively. After Blanching, the highest pulp recovery was observed in 'Steaming' as the values of pulp recovery in three varieties of nectarine fruit was recorded as 69, 68 and 68 % after these extraction techniques, highest per cent pulp recovery was observed in 'Hot lye peeling', 'Cold lye peeling' and 'Manual' techniques as the values ranged from 66 to 67, 63 to 64 and 55 to 56 %, respectively. Maximum pulp recovery was observed in 'Snow Queen' followed by 'May Fire' and 'Silver King'. The minimum and maximum value for peel recovery was observed in 'Blanching' and 'Manual' techniques of extraction. As far as stone recovery is concerned, the maximum value was observed in 'Manual' and the minimum value was observed in 'Blanching'.

(Gothwal *et al.,* 1998) extracted pulp from three varieties of plum revealed that the plums yielded 75.10, 75.20 and 75.50 % pulp in three varieties of plum viz. Santa rosa, Meriposa and Early transparent gage, respectively. The peel comprised of 10.70, 10.90 and 10.5 per cent while, stone contributed to 14.30, 14.40 and 14.0 %, respectively. (Waskar and Garande, 1999) employed different methods of extraction as blanching, cold extraction and enzymatic methods for getting the highest recovery of raw and clarified ber juices. Per cent raw juice yield as affected by different extraction methods ranged from 53.0 to 75.2.

CONCLUSION

A large number of fruit and vegetable are grown in different parts of the country including major and minor fruits. Nature has been abundantly generous to Himachal Pradesh in endowing it with conditions

conducive for growing of large variety of fruits that is why Himachal Pradesh is known as 'Fruit bowl of India'. Considering major and minor fuits, Himachal Pradesh state has made efforts to grow different cultivars of nectarine (May Fire, Snow Queen and Silver King). All the cultivars were almost same in terms of physical parameters while significant difference was seen in ash, carbohydrate, pH , ascorbic acid, brix-acid ratio and sugars among all the cultivars with highest ascorbic acid was noted in May Fire. The fruit is a rich source of potassium, phosphorous, magnesium and sodium content. Blanching treatment was the best treatment for maximum recovery of than other treatments (steaming, hot lye peeling, cold lye peeling and manual method). Hence, it can be concluded from the study that the fruit had good amount of nutrients and can be grown in other areas of the state for proper utilization of fruit in the form of value-added products with enhanced shelf life and nutrient profile.

Acknowledgments

The authors would like to thank Department of Horticulture, CSKHPKV, Palampur for providing nectarine cultivars to conduct the study.

Table 1: Variability in physical characteristics of nectarine cultivars

Parameters	Varieties			CD
	Snow Queen	May Fire	Silver King	(P≤0.05)
Length (cm)	3.97	3.95	4.07	NS
Width (cm)	4.26	4.16	4.30	NS
Weight (g)	40.90	40.10	41.40	NS
Fruit volume (ml)	40.00	40.10	41.04	NS
Specific gravity (g/ml)	1.02	1.00	1.01	NS
Colour	Reddish yellow	Reddish yellow	Reddish yellow	-
Shape	Round	Round	Round	-
Defects (if any)	-	-	-	-

* Data presented are average of triplicate determinations
* NS= Non-significant

Table 2: Variability in proximate composition of nectarine cultivars

Parameters	Varieties			CD
	Snow Queen	May Fire	Silver King	(P≤0.05)
Moisture (%)	85.80	85.93	85.75	NS
Ash (%)	0.73a	0.67 a	0.80 a	0.05
Crude Protein (%)	1.22	1.32	1.26	NS
Crude Fat (%)	0.50	0.47	0.44	NS
Crude Fibre (%)	2.05	1.98	2.00	NS
Total Carbohydrates (%)	11.91 a	11.64 a	11.81 a	0.02

*Letters with superscript shows significant difference (P≤0.05)

Table 3: Variability in chemical and functional characteristics of nectarine cultivars

Parameters	Varieties			CD
	Snow Queen	May Fire	Silver King	(P≤0.05)
Total soluble solids(?B)	10.6	10.7	10.5	NS
pH	3.30 a	3.23 a	3.20 a	0.02
Acidity (%)	0.85	0.76	0.89	NS
Ascorbic acid (mg/100g)	7.56 a	8.52 a	8.03 a	0.22
Brix-acid ratio	12.54 a	14.23 a	11.93 a	0.37
Reducing sugars (%)	5.97	5.97	5.98	NS
Non-reducing sugars (%)	2.37 a	2.11 a	1.93 a	0.07
Total sugars (%)	8.33 a	8.19 a	8.02 a	0.24
Pectin(% as Calcium pectate)	0.85	0.88	0.91	NS
?-Carotene (mg/100g)	1.16	1.15	1.29	NS
Total anthocyanin (mg/100g)	0.20	0.19	0.18	NS

*Letters with different superscript shows significant difference (P≤0.05)

Table 4: Variability in mineral composition of nectarine cultivars

Parameters	Varieties			CD
	Snow Queen	May Fire	Silver King	(P≤0.05)
Calcium (mg/100g)	6.00	5.80	6.00	NS
Phosphorus (mg/100g)	25.35 a	26.07 a	26.06 a	0.05
Magnesium (mg/100g)	8.87 a	9.00 a	8.50 a	0.15
Sodium (mg/100g)	0.22 a	0.18 a	0.25 a	0.02
Potassium (mg/100g)	202.00 a	200.80 a	200.89	1.16
Iron (mg/100g)	0.28	0.29	0.25	NS
Copper (mg/100g)	0.07	0.09	0.06	NS

*Letters with different superscript shows significant difference (P≤0.05)

Table 5 : Effect of pulp extraction techniques on the percent pulp, peel and stone recovery of nectarine cultivars

Variety / Treatment	Pulp (%)	Stone (%)	Peel (%)
Snow Queen			
Manual	55	19	26
Blanching	70	16	14
Cold lye peeling	64	16	20
Hot lye peeling	67	17	16
Steaming	69	16	15
Range	55-70	16-19	14-26
May Fire			
Manual	56	19	25
Blanching	69	16	15
Cold lye peeling	64	18	18
Hot lye peeling	67	16	17
Steaming	68	17	15
Range	56-69	16-19	15-25
Silver King			
Manual	56	20	24
Blanching	68	16	16
Cold lye peeling	63	19	18
Hot lye peeling	66	17	17
Steaming	68	17	15
Range	56-68	16-20	15-24

*Data presented are average of triplicate determinations.

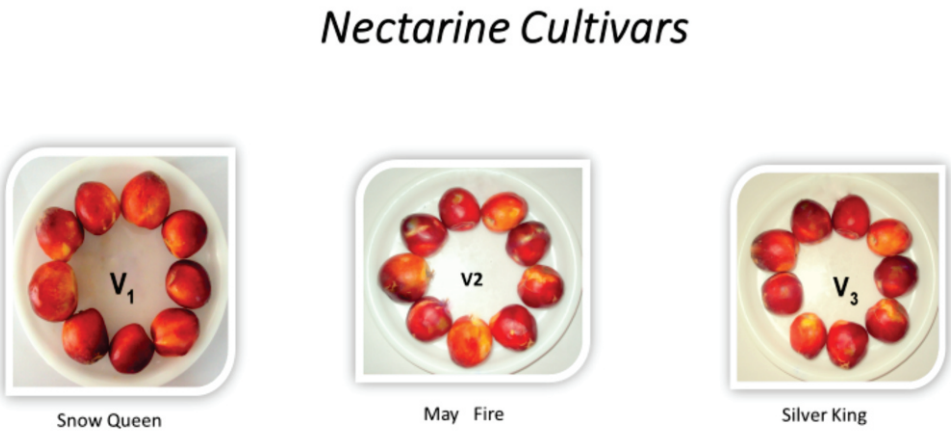


Figure 1 : Physical appearance of nectarine cultivars

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Improving Blood Sugar Level of Non Insulin Dependent Diabetics with Indian Gooseberry Powder and Curcumin Powder

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ABSTRACT

Non-insulin dependent diabetes is a global crisis that threatens the health and economy of all nations. This epidemic is primarily driven by rapid urbanization, Transition in nutritional habits, and increasing sedentary lifestyle. The present study was conducted to study the improvement in blood sugar level of non- insulin dependent diabetics with Indian gooseberry powder and curcumin powder. Snowball sampling technique was used in the present study. For sample selection door to door survey was conducted in Moti Katra and Sheetla Gali areas of Agra, Uttar Pradesh. The total sample size of the study was 18 non-insulin dependent diabetic respondents. The respondents were divided in two groups (Experimental n_1 =9 and control group n_2 = 9). Indian gooseberry powder and Curcumin powder was supplemented to experimental group diabetic respondents for 45 days. Fasting blood sugar level of experimental group was significant on 15th day, 30th day and 45th day while post prandial blood sugar level was significant on 30th and 45th day. On 45th day both fasting and post prandial blood sugar level were statistically significant ($p<0.05$) in experimental group.

Keywords: Fasting blood sugar level, Post prandial Blood sugar level, non-insulin dependent diabetics, Indian gooseberry powder, Curcumin powder

INTRODUCTION

Diabetes mellitus is a metabolic disorders of carbohydrate, protein and fat metabolism. It affects the functions of pancreatic beta cells which leads to the development of diabetes. It is associated with the long term complications of retinopathy, nephropathy and neuropathy. Diabetics are also diagnosed with the higher risk of heart disease, obesity, cataracts and cerebrovascular diseases. Diabetics have various symptoms like polydipsia, polyuria, polyphagia, fatigue, weight loss, nausea and blurred vision (Kazi & Blonde, 2001). Insulin dependent diabetes is also known as juvenile and childhood onset diabetes. It results from the deficient insulin production. Non- insulin diabetes is adult onset diabetes. It occurs due to the improper use of insulin by the body. It is the result of physical inactivity and excess body weight. There are some recommendations to cure diabetes such as healthy meals, maintaining healthy body weight and regular exercise (WHO, 2020).

Phyllanthus emblica Linn. or Emblica officinalis also known as Indian Gooseberry or Amla belongs to the family of Euphorbiaceae. Indian gooseberry holds a special place in Ayurveda and Unani system of medicine. It is the richest source of vitamin C and contains gallic acid, ellagic acid and flavonoids. It acts as an antioxidant, anti hyperlipidemia and anti hyperglycemic (Santhi *et al.,* 2017). It is very helpful to prevent the various diseases such as cancer, diabetes, liver diseases, heart diseases, ulcer, anemia and others diseases (Khan, 2009). Blood sugar level of non-insulin dependent diabetics is improved by the supplementation of Indian gooseberry powder (Walia*et al.,* 2015). Curcuma Longa belongs to the family of Zingiberaceae. It is a perennial herb with a hard rhizome (Lutra *et al.,*2001). It is widely used in Indian kitchen as a spice. It has the properties of anti- diabetic, anti-cancer and antiviral (Nabavi*et al.,*2014; Perrone *et al.,*2015). Supplementation of fenugreek, Indian Gooseberry and Curcumin is seen to reduce the blood sugar level of non-insulin dependent diabetics (Chawda &Sharma, 2017).

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MATERIALS AND METHODS

Phase I

2.1.Selection and procurement of the herbs

a. Fresh Indian gooseberry was procured from Vegetable Market of Moti Katra in Agra, Uttar Pradesh. Total raw Indian gooseberries procured was 10kg.

b. Dehydrated Curcumin was procured from Rawat Pada market of Agra, Uttar Pradesh. Total dehydrated Curcumin procured was 1.25kg.

2.2. Dehydration of herbs

a. Dehydration of Amla:

Fresh Indian Gooseberry
↓
Washing 2 to 3 times
↓
Blanching for 3 to 4 minutes
↓
Separation of seed and pulp
↓
Cut into small pieces
↓
Spread out on white cotton cloth
↓
Covered with Muslin cloth
↓
Dehydration for 16-18 days
↓
Finely grounded
↓
Sieved
↓
Kept in airtight container before packaging

b. Dehydration of turmeric:

Dehydrated Curcumin procured from market
↓
Coarsely broken in small pieces
↓
Finely grounded
↓
Sieved
↓
Kept in airtight container before packaging

Phase II

2.3. Locale of the study

An experimental study was carried out in two areas of Agra (Uttar Pradesh) namely, Moti Katra and Sheetla Gali. The reason of selecting these areas was convenience for the investigator.

2.4. Sample Selection

- Snowball sample technique was used for the present study.
- List of middle aged (40-59years) non-insulin dependent diabetics were made by door to door survey.
- Total number of diabetic respondents were twenty two. Out of twenty two diabetic respondents, four diabetic respondents dropped out.
- Total sample size of the study was eighteen.
- Selected diabetic respondents were divided in two groups (experimental group and control group). Nine respondents (n1=9) were assigned to experimental group and remaining nine diabetic respondents (n2=9) were assigned to control group.
- Sample selection period completed within ten days.

2.5. Packaging of Indian gooseberry powder and Curcumin powder for the supplementation among experimental group respondents:

	Indian Gooseberry Powder	Curcumin Powder
No. of Packets(45packets for each experimental group respondents) 45 × 9 = 405 packets	405	405
Weight of each packet	2.5gm	2.5gm

2.6.Supplementation of Indian gooseberry powder and Curcumin powder:

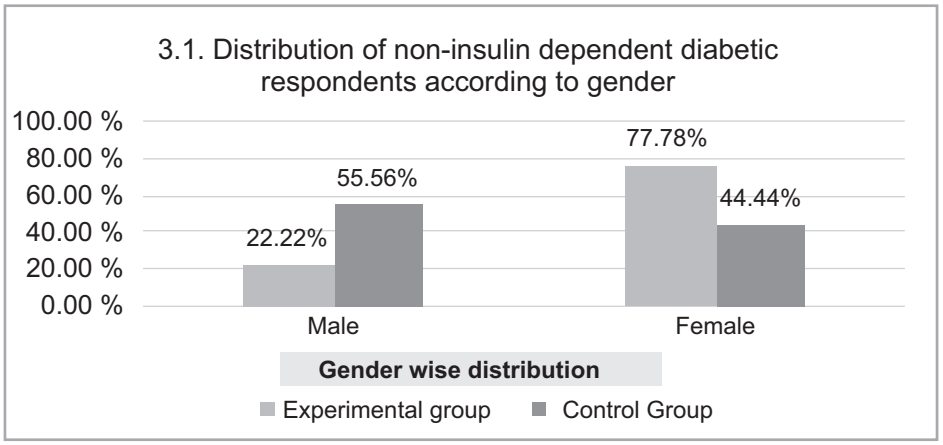
STEPS	DAYS	SUPPLEMENTATION
1	Before 15th day	Stability period without supplementation of Indian gooseberry powder and turmeric powder
2	0 day	Starting the supplementation of selected experimental respondents
3	15th day	2nd part of supplementation
4	30th day	3rd part of supplementation
5	45th day	4th part of supplementation

2.6.1. Stability Period –Investigator visited the residence of the experimental and control group respondents 15 days before starting the supplementation. Fasting and post prandial blood sugar level was taken with the help of glucometer.

2.6.2. Supplementation Period –Investigator visited the residence at early morning and provided 2.5gm Indian gooseberry and 2.5gm Curcumin powder packets to the experimental group respondents. Those packets were given on empty stomach to the respondents. Supplementation period started after 15 days of stability period and continued for 45 days. Fasting and Postprandial blood sugar level was taken with the help of glucometer on every 15th day of supplementation.

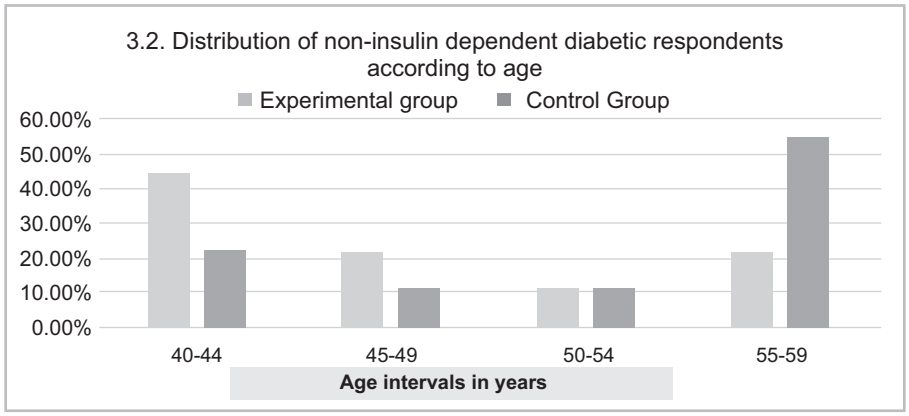
RESULTS AND DISCUSSION

3.1. Distribution of non-insulin dependent diabetic respondents according to gender:



The above data shows the distribution of non-insulin dependent diabetics according to gender. In experimental group,male and female diabetic respondents were 22.22% and 77.78% respectively. In control group, male and female diabetic respondents were 55.56% and 44.44% respectively.

3.2. Distribution of non-insulin dependent diabetic respondents according to age:



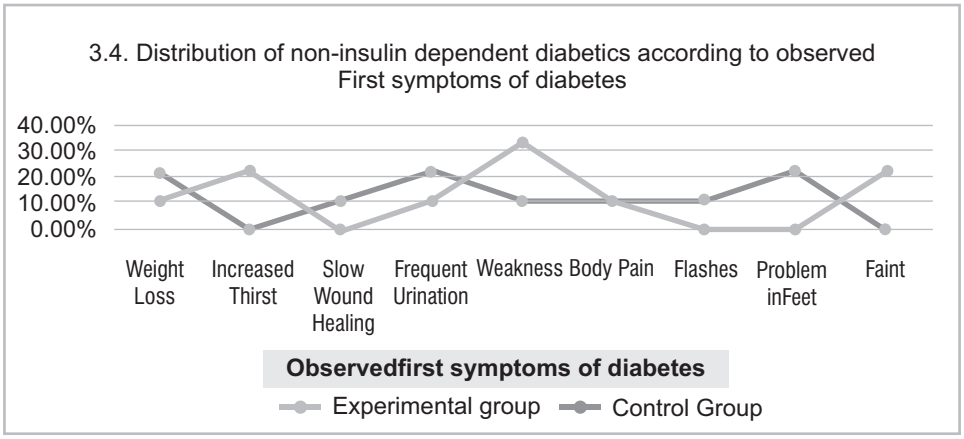
The above data shows distribution of non-insulin dependent diabetic respondents according to age. Non – insulin diabetic respondents from experimental group, 44.44%, 22.22%, 11.11% and 22.22% were in the age group of 40-44 years, 45-49years, 50-54 years and 55-59 years respectively. In control group, 22.22%, 11.11%, 11.11% and 55.56% were in the age group of 40-44 years, 45-49years, 50-54 years and 55-59 years respectively.

3.3. Distribution of non-insulin dependent diabetics according Body Mass Index(BMI):

BMI(kg/m2)	Experimental Group	Control Group
Average BMI ± SD	29.07±4.76	28.67±7.5

The above table 3.3 highlights that the body mass index of experimental and control group non-insulin dependent diabetics were 29.07 ±4.76 Kg/m2and 28.67 ±7.5 Kg/m2.

3.4. Distribution of non-insulin dependent diabetics according to Observed First symptoms of diabetes:

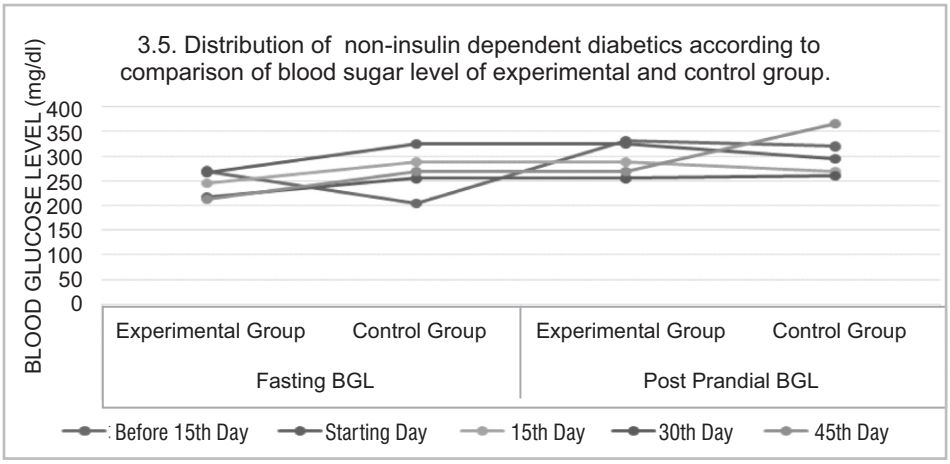


Above data highlights distribution of non-insulin dependent diabetics according to observed first symptoms of diabetes. In experimental group, majority of them 33.33% observed weakness as a first symptom, followed by 22.22% who observed increase in thirst and problem in feet as a first symptom and minimum 11.11% observed weight loss, frequent urination, body pain and flashes as a first symptom. In control group respondents, majority of them 22.22% observed weight loss and frequent urination as a first symptom and slow wound healing, weakness and body pain observed as a first symptom by 11.11% respondents each.

3.5. Distribution of the non-insulin dependent diabetics according to comparison of blood sugar level of experimental and control group:

Fasting Blood Glucose Level	Experimental Group Mean±SD (mg/dl)	Control Group Mean±SD (mg/dl)	t-Test	p-value
Before 15th Day	270.00±92.52	205.33±64.06	0.3010	0.3204
Starting Day	267.89±90.30	198.78±98.27	2.2250	0.7594
15th Day	245.33 ±9.64	152.56±74.28	3.7104	0.0260*
30th Day	217.56±94.53	162.89±58.59	5.3292	0.0101*
45th Day	213.56±85.84	212.11±68.15	4.4510	0.0100*
*This result is Statistically significant at p < .05.				
Post Prandial Blood Glucose Level	Experimental Group Mean±SD (mg/dl)	Control Group Mean±SD	t-Test	p-value
Before 15th Day	331.11±93.90	319.56±128.26	0.2740	0.5790
Starting Day	326.11±72.62	295.11±101.89	2.0209	0.4392
15th Day	288.78±85.05	269.22±95.84	1.5623	0.1093
30th Day	255.22±83.31	260.56±99.87	3.6906	0.0141*
45th Day	269.33±91.94	365.44±77.78	3.9781	0.0124*

Above table 3.5 reveals distribution of the non-insulin dependent diabetics according to comparison of blood sugar level of experimental and control group, statistically significant comparison of fasting blood sugar of both group was observed at 15th day, 30th day and 45th day of the supplementation. Statistically significant comparison of post prandial blood sugar of both group was observed at 30th day and 45th day of supplementation. Sri KVS *et al.* (2013) reported that Supplementation of Indian Gooseberry significantly decreased the fasting blood glucose level and post prandial blood glucose level of experimental group respondents. There were no significant changes in the control group respondents.



3.6. Distribution of the non-insulin dependent diabetics according to correlation between fasting and post prandial blood sugar level of experimental group)

Fasting blood sugar level (mg/dl)				
	Mean ± St. Deviation (mg/dl)	Correlation Coefficient	R-Test Value	p-value
Before 15th Day	270±92.52			
0 Day	267.89±90.3			
15th Day	245.33±97.64	0.979	0.950	0.001
30th Day	217.56±94.53	0.951	0.933	0.002
45th day	213.57±85.31	0.901	0.867	0.002

fasting and post prandial blood sugar level of experimental group:

* Statistically significant at p<0.05

Post Prandial blood sugar level (mg/dl)				
	Mean±SD. Deviation (mg/dl)	Correlation Coefficient	R-Test Value	p-value
Before 15th Day	331.11±93.9			
0 Day	326.12±72.62			
15th Day	288.78±85.05	0.901	0.783	0.001
30th Day	255.22±83.31	0.857	0.816	0.007
45th day	269.33±91.94	0.856	0.971	0.001

* Statistically significant at p<0.05

Above table 3.6 explains, by normal standards, the association between the reading of Fasting and Post Prandial Blood glucose with 15th, 30th and 45th days would be considered statistically significant and positive.

CONCLUSION

On the basis of the result obtained from the present study entitled “Improving blood sugar level of non-insulin dependent diabetics with Indian gooseberry powder and Curcumin powder” it can be concluded that prevalence of Type 2 or non-insulin dependent diabetes was very high. More females suffered from non-insulin dependent diabetes than males. Out of the eighteen diabetic respondents, twelve females suffered from type 2 diabetes. Fasting and post prandial blood sugar level was lowered with the supplementation of Indian gooseberry powder and turmeric powder for 45 days. Fasting blood sugar level was significant at 15th day, 30th day and 45th day while post prandial blood sugar level was significant at 30th and 45th day. On 45th day both fasting and post prandial blood sugar level were statistically significant (p <.05).

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In-vivo antiurolithiatic activity of *Thunbergia erecta*

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ABSTRACT

Objective: The aim of the present study was to evaluate *in-vivo* antiurolithiatic activity of a methanolic extract from the leaves of *Thunbergia erecta.* Method: The antiurolithiatic assay was performed by Ethylene Glycol alone induced urolithiasis and Ethylene glycol + Ammonium chloride induced urolithiasis model. Blood was collected through retro orbital puncture from animals under ether anaesthesia for serum separation in order to assess serum creatinine and BUN. Animals were sacrificed and both the kidneys will be excised, rinsed in ice cold physiological saline and weighed. Further analysis parameter also performed estimation of urea, kidney stone analysis, phosphate analysis, urea nitrogen analysis calcium oxalate analysis. Results: *Thunbergia erecta* 400 shows the maximum potential compared to other groups and standard. Effect of *Thunbergia erecta* extracts on kidney and urinary parameters in ethylene glycol and ammonium chloride induced wistar rats the amount of calcium, phosphates and oxalate decrease in kidney likewise in the urine. Similarly the level of BUN, uric acid and creatinine decrease at the dose of *Thunbergia erecta* 400. Conclusion: Effect of *Thunbergia erecta* extracts on serum parameters in ethylene glycol and ammonium chloride induced wistar rats. Same result exhibits in case of ethylene glycol alone with Kidney and Urinary Parameters and serum parameters. Thus we claimed that the *Thunbergia erecta* 400 shows best result for this research work which will help to researches for further analysis and studies.

Keywords: *Thunbergia erecta,* Antiurolithiatic activity, Phytochemical analysis, nucleation method

INTRODUCTION

Urolithiasis refers to the formation of calculi anywhere in the urinary tract afflicting the kidneys, ureters, bladder or urethra (Vijaya, *et al.,* 2013). It is the third most prevalent urological disorder after urinary tract infection and prostate conditions (Al-Jebouri & Atalah 2012). Approximately 12% of the world population is affected by the incidence of urinary stones with a comparatively higher frequency of recurrence in males (70-81%) than in females (47-60%) (Joy, *et al.,* 2102). Depending upon the chemical nature, there are various types of stones such as calcium oxalate monohydrate, calcium oxalate dihydrate, basic calcium phosphate (brushite), magnesium ammonium phosphate (struvite), uric acid and cystone stones (Nagal & Singla 2013). Manifestations include colicky pain, vomiting, dysuria, haematuria, pyuria and oliguria (Tiwari *et. al.,* 2012). These calculi arise as an outcome of supersaturation of urine with stone forming constituents resulting in crystallization followed by crystal nucleation, aggregation and growth leading to their adherence to the renal tubules (Agarwal *et. al.,* 2013). Numerous surgical strategies exist in scenario for management of urinary calculi such as shock wave lithotripsy, ureteroscopic lithotripsy, digital endoscopy, percutaneous nephrolithotomy and robotic surgery (Rosa *et. al.,* 2013). However, many of these techniques bring along with them several drawbacks such as renal casualties in the long run, hypertension and repeated episodes of stones (Began *et. al.,* 1991).Several allopathic interventions are available but are increasingly being overtaken by herbal therapeutics on account of their safety, minimal side effects, comparatively greater efficacy in dissolving stones and preventing the chances of recurrence (Alok *et. al.,* 2013). Moreover, the applications of medicinal plants in combating urinary stones have been extensively mentioned in the ancient medical literature as well as Ayurvedic system of medicine in addition to their relevance as folk remedies (Chitme *et. al.,* 2010). *Thunbergia erecta* (Syn: *Meyenia erecta,* Acanthaceae) is also known as King's Mantle, Blue Bell and Bush Clock Vine (Manokari & Shekhawat, 2017). It is woody,

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straight shrub which has 2-2.5 m altitude. It contains flower that blooms throughout the year and has blue to purple color range (Kitajima *et. al.,* 2010). *Thunbergia* is native to the tropical part of Madagascar, Australia, Africa, India and South Asia. Leaves, roots and stems of *Thunbergia* species have the traditional history to be used for the treatment of inflammation and pyrexia (Jeeva *et. al.,* 2011). *Thunbergia* species have been reported to show antibacterial effects against both gram positive and gram negative bacteria (*Oonsivilai et. al.,* 2008). *Thunbergia* species also possess analgesic, antipyretic, anthelmintic, antidiabetic, cytotoxic, antioxidant, hepatoprotective (*Oonsivilai et. al.,* 2008 & Wonkchalee *et. al.,* 2008), antitumor and antinociceptive activities (Jetawattana *et. al.,* 2015). Chemical ingredients separated from *Thunbergia* genus include alkaloids, glucosides, naphthalene, coumaroylmalic acid, iridoidglucosides, grandifloric acid, benzyl beta glucopyranoside, delphinidin, apigenin and phenolic compounds such as tannin, feruloylmalic, flavonoids, phenolic acids, rosmarinic acid (Kanchanapoom *et. al.,* 2002 & Areekul *et. al.,* 2009). Therefore, current investigation was carried out for the screening of the antilithic potential of *Thunbergia erecta* against calcium oxalate crystallization in an in vitro setting.

MATERIAL AND METHOD

Selection and Collection of Plant

The leaves of *Thunbergia erecta* were collected in the month of July 2019 from the Pinnacle Biomedical Research Institute, Bhopal Campus.

Authentication of Plant

The identification and authentication of plant was done by Dr. Saba Naaz, Botanist, from the Department of Botany, Saifia College of Science and Bhopal. A voucher specimen number 195/Saif. /Sci./Clg/Bpl. was kept in Department of Botany, Saifia College of Science, Bhopal for future reference.

Pharmacological study (*In vivo* studies)

Animals were selected randomly from animal house of Pinnacle Biomedical Research Institute (PBRI), Bhopal, India and further divided into various treatment groups randomly and kept in propylene cage with sterile husk as bedding. Relative humidity of 30.7 % at 22±2 °C and 12:12 light and dark cycle was maintained in the animal house and fed with standard pellets (Golden Feeds, New Delhi, India) and water was available *ad libitum*. Institutional Animal Ethics Committee (IAEC) of PBRI, Bhopal has approved all animal experiments with CPCSEA Reg. No.-1824/PO/ERe/S/15/CPCSEA. Protocol reference No. is PBRI/IAEC/PN-16027.

Animals used

- Strain - *Albino Wistar* rats
- Age - 5-6 weeks
- Sex - either sex
- Body weight - 200±20 g

Acute oral toxicity

Acute toxicity was performed as per OECD 423 guidelines and three albino rats per step were selected. Two to four steps may be necessary to allow for making a judgment on the acute toxicity of the test substance depending on the mortality and/or the morbidity status of the animals.

In-vivo Urolithiasis Activity

Ethylene Glycol alone induced urolithiasis model

Ethylene glycol induced hyperoxaluria model (Atmani *et al*., 2003) was used to assess the antilithiatic activity in albino rats. Ethylene glycol (0.75%) in drinking water was fed to different groups for induction of renal calculi till 28th day.

Ethylene glycol + Ammonium chloride induced urolithiasis

To study the effect of test material on CaC_2O_4 urolithiasis, group I rats, serving as vehicle treated control, received vehicle once in 24 h, whereas, the untreated rats (group II) received stone inducing treatment for 21 days, comprised of 0.75% (w/v) Ethylene Glycol with 1% (w/v) ammonium chloride for 5 days, following this the water supply will be switched to 0.75% EG alone in water, along with vehicle treatment. Other treatment group was given test sample/ standard anti-urolithic drug dissolved/suspended in vehicle once in 24 h and simultaneously received stone inducing treatment similar to the untreated groups.

Analysis Parameters (For *in-vivo* model)

The activity was regularly monitored to assess their overall health so that any animal looking lethargic or excessively losing weight could be excluded from the study.

Blood was collected through retro orbital puncture from animals under ether anaesthesia for serum separation in order to assess serum creatinine and BUN. Animals were sacrificed and both the kidneys were excised, rinsed in ice cold physiological saline and weighed.

Kidney Homogenate Analysis

The abdomen was cut open to remove both kidneys from each animal. Isolated kidneys were cleaned off extraneous tissue and preserved in 10% neutral formalin. The kidneys will be dried at 80˚C in a hot air

oven. A sample of 100 mg of the dried kidney was boiled in 10 ml of 1N hydrochloric acid for 30 min and homogenized. The homogenate was centrifuged at 2000×g for 10 min and the supernatant were separated. The calcium phosphate and oxalate content in kidney homogenate was determined.

Urea nitrogen

Blood urea nitrogen was estimated by Berthelot method (Fawcett & Scott, 1960) using the commercially available kit (Kamineni Life Sciences Pvt. Ltd. Hyderabad, India). Working reagent-I up to 1000 µl of containing urease reagent, and a mixture of salicylate, hypochlorite and nitroprusside was added to 10 µl of serum, 10 µl of standard urea (40 mg/dl) and 10 µl of purified water to prepare test, standard and blank, respectively. All the test tubes were mixed well and incubated at 37 °C for 5 min. Then 1000 µl of reagent-II containing alkaline buffer, was added to all the test tubes, which were incubated at 37 °C for 5 min. Urease catalyses the conversion of urea to ammonia and carbon dioxide. The ammonia thus released reacts with a mixture of salicylate, hypochlorite and nitroprusside to yield indophenol, a blue-green coloured compound. The intensity of the colour produced is directly proportional tothe concentration of urea in the sample and is measured spectrophotometrically at 578 nm.

The blood urea was calculated using the following formula:

Blood urea nitrogen (mg/dl) = Serum urea X 0.467.

Estimation of Calcium oxalate

Calcium has numerous functions within the body, not only as a structure factor in bones and teeth but also in normal neuromuscular function and the clotting of blood. Estimation of calcium was estimated by O-Cresolphthaleincomplexone (OCPC) method (Moorehead & Briggs, 1974) using the commercially available kit (Transasia Biomedicals Ltd. baddi). Reagent 1 containing 2-Amino-2-methyl-1-propanol and reagent 2 containing OCPC, 8-hydroxy Quinoline and HCl, add in equal volume and allow to stand at room temperature. Then take absorbance at 578 nm.

Calcium (mg/dl) = Abs. of Test/Abs of standard× conc. of standard (mg/dl)

Estimation of Phosphate

Phosphate was estimated by Berthelot method (Daly & Ertingshausen, 1972) using the commercially available kit (vital Diagnostics Pvt. Ltd. Thane, India). Molybdate reagent using as a working reagent for estimation of phosphate present in urea. And take absorbance at 340 nm.

Estimation of Urea

Urea was estimated by Berthelot method (Gutmann & Bergmeyer, 1974) using the commercially available kit ((Transasia Biomedicals Ltd. baddi), India). Reagent 1 and aqua 4 added equally and attain the temperature 15-30° C. reagent and serum was added in appropriate volume then take absorbance at 340nm.

Biostatical interpretation

Data was calculated as Mean ± SD/SEM. One-way ANOVA was used to interpret the results followed by Bonferroni's test. $P<0.001$ was considered as level of significance.

Statistical Analysis

The data are represented as mean ± S.E.M, and statistical significance was carried outemploying one way analysis of variance (ANOVA) followed by Dunnett t-test where $p<0.05$ wasconsidered statistically significant using Graph pad 5 software.

RESULT & DISCUSSION

Acute Oral Toxicity

Toxicity testing of new compounds is significant for drug development process. The toxicity of the substances can be determined on experimental animals by analyzing accidental exposures to an in vivo substance. Acute oral toxicity study of methanolic extract of *Thunbergia erecta* according to OECD-423 guidelines in mice.

Table 1: Acute oral toxicity of extract of selected plants (in albino wistar rat)

S. No.	Dose	No. of animal	Mortality* Methanolic
1.	5 mg/kg	Three	0/3
2.	50 mg/kg	Three	0/3
3.	300 mg/kg	Three	0/3
4.	2000 mg/kg	Three	0/3
5.	5 mg/kg	Three	0/3
6.	50 mg/kg	Three	0/3
7.	300 mg/kg	Three	0/3
8.	2000 mg/kg	Three	0/3

*x/3: x animals dead in 3 test animals

To ascertain safety of any component its acute oral toxicity is an important parameter to assess. Toxicity was assessed at 5 mg/kg, 50 mg/kg, 300 mg/kg and 2000 mg/kg. As per OECD 423 guideline up to the dose of 2000 mg/kg safety was assessed. All two extracts were found to be safe at all selected doses. As all two extracts were safe up to the dose of 2000 mg/kg and no mortality was observed (Table), dose

was selected accordingly.1/10th and 1/5th of 2000 mg/kg was selected as dose for present investigation. Doses selected were 200 mg/kg and 400 mg/kg (Rosa *et al.,* 2013; Wonkchalee *et al.,* 2012).

***In vivo* anti urolithiasis activity**

Urolithiasis or kidney stone formation is a complex process which take place due to supersaturation of stone forming constitute like calcium, oxalate, uric acid, urea, phosphate in urine and an imbalance of inhibitors like glycosaminoglycans, magnesium. Herbal medicines have many phytoconstituents which may exert their beneficial effect alone or in combination in kidney stone treatment. Plant extracts contain phytochemicals that inhibit stone formation by inhibiting synthesis and agglomeration of crystals (Vijaya *et al.,* 2013).

Ethylene glycol and ammonium chloride induced model (EG+NH_4Cl Model)

In the present study, methanolic extracts of the leaves of *T. erecta* were assessed for its anti-urolithiatic activity in ethylene glycol and ammonium chloride induced urolithiasis in rats and the results obtained were recorded.

Table 2: Effect of Thunbergia erecta extracts on Kidney and Urinary Parameters in Ethylene Glycol and ammonium chloride Induced Wistar Rats

Group No.	Treatment	In kidney			In urine		
		Oxalate	Calcium	Phosphate	Oxalate	Calcium	Phosphate
I	Control	1.21±0.157	1.94±0.333	1.53±0.174	0.29±0.078	1.12±0.085	2.44±0.359
II	EG+NH4Cl Control	6.72±0.306*	5.48±0.407**	5.30±0.544	4.13±0.528**	5.28±0.256	7.03±0.500
III	Standard	1.37±0.356	2.77±0.543	1.95±0.464	0.77±0.121	1.52±0.264	3.08±0.214
IV	TE 100	3.40±0.623	4.07±0.356**	3.30±0.681	2.77±0.524	3.30±0.482	4.56±0.149
V	TE 200	2.43±0.339*	3.33±0.524	2.72±0.172	2.02±0.256	1.95±0.383	3.53±0.378
VI	TE 400	1.83±0.294	2.85±0.729	2.67±0.513	1.30±0.155	1.68±0.519	3.12±0.838

*Mean ± SEM (n = 6). Significant at **p<0.01 compared to control group.

Table 3: Effect of Thunbergia erecta extracts on Serum Parameters in Ethylene Glycol and ammonium chloride Induced Wistar Rats

Group No.	Treatment	In Serum		
		BUN	Uric acid	Creatinine
I	Control	25.53±1.324	1.03±0.040	0.58±0.065
II	EG+NH4Cl Control	59.53±1.544	4.77±0.532	2.48±0.376*
III	Cystone 750	27.27±3.653	1.52±0.349**	0.70±0.050
IV	TE 100	48.60±4.590**	2.67±0.412	1.32±0.109*
V	TE 200	41.48±5.601	2.45±0.345	1.10±0.055
VI	TE 400	33.28±2.193	1.91±0.802	0.96±0.122

*Mean ± SEM (n = 6). Significant at **p<0.01 compared to control group.

Kidney and Urine Analysis

The kidney parameters of the rats were assessed by evaluating the oxalate, calcium and phosphate concentrations in the kidney homogenate. For kidney, EG+NH4Cl control gave the value of oxalate, calcium and phosphate as 6.72±0.306, 5.48±0.407, 5.30±0.544 respectively. Negative control showed decrease in value as 1.21±0.157, 1.94±0.333, 1.53±0.174 of oxalate, calcium and phosphate respectively. TE 100 showed increase in value of oxalate, calcium and phosphate i.e., 3.40±0.623, 4.07±0.356, 3.30±0.681 respectively. TE 400 was not found to be effective as it gave lowest increase level of oxalate, calcium and phosphate as 1.83±0.294, 2.85±0.729, 2.67±0.513 respectively (Wesson *et al.,* 1998).

Similarly for urine, EG+NH4Cl control gave the value of oxalate, calcium and phosphate as 4.13±0.528, 5.28±0.256, 7.03±0.500. Negative control showed decrease in value as 0.29±0.078, 1.12±0.085, 2.44±0.359 of oxalate, calcium and phosphate respectively. TE 100 showed increase in value of all three constituents as 2.77±0.524, 3.30±0.482, 4.56±0.149 whereas in TE 400 all the three constituents showed decrease in value i.e., 1.30±0.155, 1.68±0.519, 3.12±0.838.

Ethylene Glycol Induced Alone model

In the present study, methanolic extracts of the leaves of *T. erecta* were assessed for its anti-urolithiatic activity in ethylene glycol alone induced urolithiasis in rats and the results obtained were recorded (Hennequin *et al.,* 1993).

Table 4: Effect of Thunbergia erecta leaves Extract on Kidney and Urine Parameters in Ethylene Glycol Alone

Group	Treatment	In kidney			In urine		
No.		Oxalate	Calcium	Phosphate	Oxalate	Calcium	Phosphate
I	Control	1.00±0.018	1.71±0.136	1.55±0.131	0.24±0.053	1.18±0.053	2.53±0.271
II	EG Control	7.37±0.464	6.00±0.260	5.93±0.319	4.60±0.358	5.63±0.149	7.30±0.249
III	Standard	1.79±0.147	2.70±0.293	1.98±0.263	0.79±0.093	1.65±0.187	3.11±0.115
IV	TE 100	4.39±0.517*	4.33±0.301	3.84±0.264	2.82±0.217**	3.72±0.162	4.94±0.397
V	TE 200	3.74±0.312	3.66±0.108**	3.26±0.093	2.46±0.113	2.52±0.166**	3.90±0.156
VI	TE 400	2.96±0.153*	2.82±0.386	2.35±0.201	2.11±0.187	1.98±0.143	3.14±0.125

*Mean ± SEM (n = 6). Significant at **p<0.01 compared to control group.

Table 5: Effect of Thunbergia erecta leaves Extract on Serum Parameters in Ethylene Glycol Alone

Group No.	Treatment	In Serum		
		BUN	Uric acid	Creatinine
I	Control	30.39±1.993	1.08±0.063	0.62±0.088
II	EG Control	61.33±7.394	4.82±0.307	2.51±0.267
III	Cystone 750	36.17±3.061	1.68±0.407	0.79±0.113
IV	TE 100	50.99±3.481*	2.74±0.266**	1.51±0.221*
V	TE 200	42.87±4.741**	2.48±0.190	1.16±0.073**
VI	TE 400	37.77±4.840**	1.97±0.580*	1.04±0.123

*Mean ± SEM (n = 6). Significant at **p<0.01 compared to control group.

CONCLUSION

From the present research work we conclude that the TE 400 shows the maximum potential compared to other groups and standard. Effect of *Thunbergia erecta* extracts on Kidney and Urinary Parameters in Ethylene Glycol and ammonium chloride induced Wistar Rats the amount of calcium, phosphates an oxalate decreases in kidney likewise in the urine. Similarly the level of BUN, uric acid and creatinine decreases at the dose of TE 400 in effect of *Thunbergia erecta* extracts on serum parameters in ethylene glycol and ammonium chloride induced wistar rats. Same result exhibits in case of ethylene glycol alone with Kidney and Urinary Parameters and serum parameters. Thus we may claimed that the TE 400 shows best result for this research work and go for further analysis and studies.

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Formulation and evaluation of transdermal patches of isolated compound from plant extract for in-vivo anti-inflammatory activity

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ABSTRACT

The aim of present research work was to formulate and evaluate the transdermal patches of isolated compound from plant extract for their *in-vivo* anti-inflammatory activity. Suitable parameters for the phytochemical screening, physicochemical characterization, preformulation of transdermal patches, drug content, *in-vitro* drug release and *in-vivo* anti-inflammatory activity of formulated transdermal patches. The anti-inflammatory activity decreased with increasing time in case of control (Indomethacine) group whereas the curcumin (400 mg/kg) showed maximum activity at maximum time (12 h) the activity increasing with increasing time intervals. The activity of formulation having dose rate 20 mg/kg bodyweight was decreasing with time intervals. The formulation having dose rate 40 mg/kg was better than formulation 20 mg/kg. Curmumin showed maximum activity compared to other formulations and standard. These parameters can serve as quality characters and criteria for the evaluation of the identity and authenticity of the plant.

Keywords: Transdarmel, Extract, Anti-inflammatory, Curcumin,Indomethacine

INTRODUCTION

Herbal medicine also referred to as botanical medicine or phytomedicine refers to the use of plant seeds, berries, roots, leaves, bark or flowers for medicinal purposes. Herbal medicines are gaining popularity worldwide for human well-being and healthcares based on their positive therapeutic results and are gaining resurgence among the consumers throughout the world (Ajayi *et al.,* 2011; Das, 1991; Srikanthmurty, 2000). The Consumption of herbal medicines is widespread and increasing. There is growing concern about diminishing populations of some medicinally important plant species, loss of genetic diversity, local extinctions and their habitat degradation. Herbal revival is happening all over the planet. People are taking note of herbal remedies for the treatment of various kinds of diseases in place of conventional allopathic treatment. There is increasing attention in traditional system of medicine due to superior outcome and minimum side effect as compare to conventional medicines. There are main three reasons for popularity of herbal drugs:

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1. Modern drugs are failing to efficiently treat many of the health conditions like gout, arthritis, tuberculosis, skin diseases, AIDS, upper and lower respiratory problems etc.
2. Trustworthy and safe
3. They produce better results without side effects

Herbal remedies are commonly used to treat various health conditions like tuberculosis, skin diseases (psoriasis), melanoma, hepatic, immune-deficiency, acute respiratory and rheumatologic disorders. World health organization (Geneva) estimates that about 33.33 percentage of the world's population now a day use herb and formulations made up from natural sources for to treat various ailments(Varrier, 1996; Jagtap &Karkera, 1999; Ahmad *et al.,* 1998).The easiest approach for administration of drugs and bioactive molecules is through the transdermal route. Many of the therapeutic agents undergo drug-food interaction when it is given by oral route. However, transdermal route avoids the wastage of the drug and provides an attractive way of usage (Sato *et al.,* 1997). A wide range of medications and chemical entities are available in the market as transdermal dosage forms. The delivery of drugs via the transdermal route has certain merits such as accurate dosing, termination of medication, easy to apply (self-medication) and avoids sensation of nausea which is observed when the drug is administered through oral route (Purseglove *et al.,* 1981).

The concept of transdermal drug delivery system (TDDS)was proposed by United States (US) scientists in and around 1980s and 90s. The first TDDS was introduced in the US over 20 years ago. Initially a number of the US pharmaceutical companies showed interest in developing the transdermal dosage forms. But excitement dwindled to disappointment, because of the limitation that only few drug molecules could be designed for transdermal delivery (Ashraf *et al.,* 2012; Priyadarsini, 2014).

MATERIALS & METHODS

Chemicals

Curcumin, Chitosan, Poly vinyl alcohol, Poly ethylene glycol, Glycerol, Lactic acid and Carrageenan. All the chemicals were purchased from S D fine chemicals Mumbai and all chemicals and materials were of analytical grade used for this project work.

Selection and Authentication of Plant

The rhizomes of *Curcuma longa* were collected from Bhopal and authenticated by botanist from the Department of Botany, Saifia Science College, and Bhopal. Plant authentication number:(specimen number BT/10/22/Saifia/Science/College/Bhopal)

Solvent Extraction

Collected plant material washed under running tap water and kept in shade for drying. Plant material was extracted by continuous hot percolation method using Soxhlet apparatus. Powdered material of rhizomes of *Curcuma longa* were placed in thimble of soxhlet apparatus. Soxhlation was performed at 60°C using petroleum ether as non-polar solvent. Exhausted plant material (marc) was dried and afterward re-extracted with ethyl acetate and methanol solvent. Dried extract was weighed and percentage yield for each extract was determined (Maiti *et al.,*2007).

Phytochemical investigation:

Qualitative photochemical investigation: The phytochemical investigation was carried out by procedure given byKokate*et al.,* 1993.

Isolation of Plant Component

Thin layer chromatography

Thin Layer Chromatography of *Curcuma longa* extract was carried out on silica gel coated and activated (0.4-0.5mm thick) glass plates in an oven at 100°C for 30 min. These plates were developed in an organic solvent mixture, air dried and visualized under UV light. Spots were observed with distinct RF value (Rana *et al.,* 2016).

R_f= Distance travelled by the compound.
Distance travelled by the solvent front.

Column chromatography

For the isolation of bio active components from methanol extract of *Curcuma longa* columns was prepared. The bottom of the columns (45 cm length, 12 cm diameter) were packed with adsorbent cotton, above which silica gel (60 g) was filled as a slurry in petroleum ether. Care was taken to prevent entrapment of air bubbles into the columns. About 2 g of the methanol extract of *Curcuma longa* was dissolved in methanol, dispersed uniformly in 20 g of silica gel and loaded over the filled columns. The column contents were eluted with gradient elution starting with (100:0) pet ether followed by pet ether, chloroform, ethyl acetate and methanol. Each time, 30 ml of elute was collected. The separation was done by gradient elution with low polar to high polar (gradient from 100% low polar/0% high polar to 0% low polar/100% high polar) using the flow rate of 1 ml/min. Elution of different components was monitored by TLC to know the nature of compounds in the fractions and homogeneity of the compounds. Fractions showing similar spots with same Rf values were pooled and concentrated with evaporating temperature of 40°C (Vavilova, 1990).

Preformulationstudies

Preformulation studies were conducted to confirm the drug identity, solubility profile for drug release receptor media and for compatibility of drug with other excipients of matrix transdermal formulations. In our experiment, Preformulation studies were performed or classified into three sections:

A. Preparation of phosphate buffer saline, pH 7.4
B. Preparation of standardcurve.
C. To acquired physicochemicalproperties.

A. Preparation of phosphate buffer saline, pH7.4:

Phosphate buffer saline pH 7.4 was prepared according to Indian pharmacopeia (IP, 2010). 8.0 g of sodium chloride (NaCl), 0.19 g of potassium dihydrogen phosphate (KH_2PO_4) and 2.38 g of disodium hydrogen phosphate (Na_2HPO_4) was dissolved in sufficient water (H_2O) and volume was made up to 1000ml with distilled water. The buffer pH was arranged to 7.4 using hydrochloric acid (HCl) and sodium hydroxide(NaOH).

B. Preparation of standardcurve:

Standard curve of curcumin was prepared in ethanol by using UV spectrophotometric analysis.

Stock solution A: Stock solution A was prepared by dissolving 10mg curcumin in ethanol and volume make up to 10ml with ethanol to produce 1000µg/ml solution.

Sub-stock solution B: 2.5 ml of stock solution A was taken into 25 ml volumetric flask; make up volume up to 25ml to produce sub-stock solution B(100µg/ml).

Preparation of aliquots: Further, serial aliquots range from 1 µg/ml to 5 µg/ml was prepared from sub-stock solution B.

Scanning of aliquots was carried out spectrophotometrically via Shimadzu 1700 UV-Visible spectrophotometer ranging from 300 nm to 500 nm. The λmax of curcumin was obtained at wavelength of 424 nm. Calibration curve of curcumin was prepared by plotting absorbance value against concentration of drug.

C. Investigation of physiochemical characteristics of curcumin

Organoleptic characteristics:

Color: Color of curcumin was determined by physical appearance.

Taste and odor : Extremely minute amount of curcumin was used to acquire taste of drug with the help of tongue as well as smelled to get the odor of drug.

Melting point: A small amount of pure curcumin was taken in fused capillary tube. Fused tube positioned in melting point apparatus (VEEGO).

Determination of partition coefficient: Partition coefficient is one of the most important parameter for a measurement of lipophilicity of drugs, which can help to predict its potentiality to cross the biological membrane. The partition coefficient (Po/w) of drug was calculated by using the following formula: Po/w = Concentration of drug in n-octanol / Concentration of drug in PBS (Afaq *et al.,* 2002).

Development of transdermal patch:

Preparation of transdermal patch involves two steps:

1. Preparation of backing membrane:
2. Preparation of matrix system:

Preparation of backing membrane:

A backing membrane of transdermal patch was prepared from 4%w/v aqueous solution of PVA (poly vinyl alcohol). The mixture (4g PVA in 100 mL water) was stirred with heating between 70-80 °C till a clear solution was obtained. Obtain clear solution was cooled at room temperature and sonicated for 15 min to remove any entrapped air. 10 ml of this solution was poured into a petri dish (25 cm^2 area) and solution was dried for 24 hours at room temperature.

Preparation of matrix system

The matrix type patches of curcumin were formulated using different quantity of chitosan and different permeation enhancers by solvent evaporation method. Polymer solution was prepared by taking the appropriate quantity of chitosan and dissolved in 4% v/v aqueous solution of lactic acid in 50 mL. The chitosan solution was homogenized at 1500rpm until clear solution obtained (Approx. 2-3 h). Glycerol used as plasticizer were added and homogenized for 30 min. Drug (50 mg) was added and 3-4 mL methanol (Work as co-solvent for drug) added into homogeneous dispersion and homogenized for 30 min. A known quantity of permeation enhancers (Propylene glycol or oleic acid) were added drop by drop into the solution and again homogenized for 30 min. To remove entrapped air bubble in the dispersion, the beaker was placed in the sonicator at room temperature until all the air bubbles were removed. The uniform dispersion was poured on the PVA backing membrane cast earlier. The petri dish was covered with an inverted funnel to control the rate of evaporation of solvent. This matrix dispersion was kept undisturbed at room temperature for 48 hours in order to evaporate the solvent. After complete drying, the transdermal patches were peeled from the Petri dish and cut in square patches. The patches were properly wrapped in aluminium foil and kept in desiccators for further uses (Ammon & Wahl, 1991).

Table 1: Composition of prepared transdermalpatches

S. No.	Formulation Code	Chitosan (mg)	Drug (mg)	Glycerol (mL) (mL)	Propylene glycol	4% Aqueous solution of lactic acid (mL)
1.	FC1	200	50	0.15	0.25	15
2.	FC2	300	50	0.15	0.25	15
3.	FC3	400	50	0.15	0.25	15
4.	FC4	500	50	0.15	0.25	15
5.	FC5	600	50	0.15	0.25	15

Evaluation of Prepared transdermal patches

Physical Appearance

All the prepared patches were visually inspected for physical appearance like clarity, smoothness, color, flexibility.

Thickness

The thickness of the prepared patches was measured by using digital Vernier caliper

(Aerospace, range 0-150 mm) at three random sites.

Weight variation

The three patches of each formulation were cut in 3.5×3.5 cm^2 and weighed in digital balance (Contech Analytical Balance) individually.

Folding endurance

This test is very important for determining and checking the efficiency of plasticizer. Folding endurance is defined as the number of times polymeric film folds without break and crack. This test was carried out manually by repeatedly folding a patch at same location until it broke.

Percentage Moisture Loss

Percentage moisture loss parameter was used to check the physical stability of patches in dry condition. The three patches (1.5×1.5 cm^2) from each formulation were individually weighed accurately and placed in a desiccators having anhydrous calcium chloride at room temperature (26±1 °C) for 72 hr. During this interval, the patches were weighed again after 12, 24 and 48 hr. The individually percentage moisture loss was calculated from the formula given below:

$$\% \text{ Moisture loss} = \frac{\text{Initial Mass - Final Mass}}{\text{Initial Mass}} \times 100$$

Water vapor permeation test

The quantity of moisture transmitted through unit area of patch in unit time was determined by water vapor permeation test. Glass vials of equal volume were used in this study. Glass vials were washed properly and dried in hot air oven. 1 gm anhydrous calcium chloride was taken in each glass vial and the medicated films were fixed over the brim of the glass vials with the help of adhesive tape. Then these glass vials were weighed accurately and stored at 84% RH in desiccators having saturated solution of potassium chloride. These glass vials were removed (from desiccator) and reweighed after 24, 48, 72 hrs. To determine the weight gain. Water vapor permeation (WVP) was calculated by using following formula:

$$WVP = \frac{WT}{S}$$

Where, W is weight of water vapor permeated, T is the thickness patch and S is Surface area exposed by film over the brim of vials in square centimeter.

Weight of water vapor permeated (W) was determined as follow:

W= Final weight – Initial weight (After different time interval)

Determination of drug content

Films of 3.5×3.5 cm^2 were cut and placing in a volumetric flask containing 100 ml of phosphate buffer saline and ethanol, at room temperature (26±1 °C). The mixture was stirred at magnetic stirrer for 24 h and solution was filtered through Whatman filter paper (pore size 0.45µm). Absorbance of filtrate was taken by UV visible spectrophotometer at 425 nm. The drug content was calculated from the absorbance value (Jain *et al.,* 2019).

***In-Vitro* drug release studies**

In-vitro release studies were carried out by modified Franz diffusion cell. The release studies were performed using egg membrane (Biological membrane). The egg membrane was removed using diluted solution of hydrochloric acid. Subsequently egg membrane was cleaned using distilled water, and immersed in phosphate buffer saline and ethanol for half an hour. A section of egg membrane was cut and tied on donor compartment using thread. The transdermal patch was placed on donor compartment in such manner facing the matrix side of the patch to the egg membrane and backing membrane opposite side. The receptor compartment of modified diffusion cell was filled with adequate volume of phosphate buffer saline (pH 7.4) and ethanol, whose temperature was kept 37±2 °C and stirred at 500 rpm. Followed by the holder (Donor compartment) containing membrane and patch was placed on receptor compartment of modified diffusion cell. Whole system was positioned on a magnetic stirrer and solution of receptor compartment was stirred continuously at 500 rpm using a magnetic bead. The release study was carried out for 48 hours (Jain *et al.,* 2012).

The samples (3.0 ml each time) were withdrawn from receptor compartment at different time intervals and added an equal volume of phosphate buffer saline (pH 7.4) and ethanol to maintain sink condition. The collected samples were subjected to UV spectrophotometer at 425 nm against phosphate buffer saline (pH 7.4) and ethanol as blank.

Animal studies

The animal studies were carried out according to approval of institutional animal ethical committee (Protocol No: PH/IAEC/VNS2K19/11). Wistar rats were housed in cages, given free excess of laboratory diet and water. All rats were housed in laboratory having facilities of air conditioner and cycle of 12 h dark and 12 h light.

Skin irritation study

Young rats having weight 200-250 g were divided into two groups, each containing three rats. The backside of rats was shaved before 12 h to conduct the experiments. To the control group (group I), an adhesive tape was applied. To the test group (groups

II), transdermal patches FP3 was applied on the dorsal surface of the rats. The animals received new patch every day up to 5 days. The patch was detached after 5 days. The rats were observed for erythema and edema sign after study period of 5 days and scored by draize scoring method as score 0 given for no erythema, 1 given for very slight erythema (light pink), 2 given for well- defined erythema (dark pink), 3 given for moderate to severe erythema (light red), and 4 given for severe erythema (dark red).

Therapeutic study (Carrageenan induced paw edema)

Young rats having weight 200-250 g were used to perform the experiment. The backside of rats was shaved 12 h before starting the experiments. The study was divided into two sections; section 1 in which formulations were applied before 2 hr of carrageenan insult and section 2 in which formulations were applied before 12 hr of carrageenan insertion.

Section 1 has two groups and each group contain 3 rats. Section 1 was utilized for determination of immediate drug release and action. Group I (Vehicle treated+0.2 ml of 1% carrageenan sub-plantar) rats have received only a sub-plantar injection of carrageenan. Group II (Transdermal patch of curcumin + 0.2 ml of 1% carrageenan sub-plantar) have received prepared patch. Similarly section 2 has also two groups, To induce paw edema in section 1 rats, after 2 h of application of formulations in all the rats were injected (sub-plantar) with 0.1 mL of a 1% w/v homogeneous suspension of carrageenan (in double distilled water) in the right paws.

Whereas in section 2, carrageenan injection was injected in rats after 12 h of application of formulation. The hind paw volume was measured (In both of section) at 0, 1, 2, 3, 4, 5, 6 and 24 h after carrageenan injection using a plethysmometer and expressed as a percentage of edema relative to initial hind paw volume.

***In vivo* Anti-Inflammatory Activity**

Carrageenan-Induced Rat Paw Edema Model

The rats were divided into five groups containing six rats each and acute inflammation was induced according to edema assay. The extract and formulations were evaluated for the anti-inflammatory activity. Acute inflammation was produced by subplantar injection of 0.1 ml of 1% Carrageenan in normal saline in the right hind paw of the rats. After 30 min of carrageenan induction standard marketed preparation was applied to animals of group II whereas group III, IV and V animals received topical application of curcumin extract alone and test formulations (10 and 20 mg/kg) respectively. Reduction in edema was measured at every 15 min up to 12 h. Percent change in paw volume was calculated. The anti-inflammatory activity was calculated as percentage inhibition of Carrageenan induced paw edema using the following formula.

% Inhibition = [(A control - A test)/ A control] x 100

Statistical Analysis

The data is expressed as mean ± Standard Deviation (SD). Results were analyzed using one-way ANOVA followed by Bonferroni test. Differences were considered as statistically significant at $P < 0.05$, $P<0.001$ when compared with control.

RESULTS & DISCUSSION

Percentage Yield

The rhizomes of the *Curcuma longa* were extracted by Soxhlet extraction and the percentage yield calculated by the formula Yield (%) = Weight of the residue obtained/Weight of the plant material taken×100 was found to be % (petroleum ether) and % (methanol).

Table 2: Percentage yield of different fruits and rhizomes extracts of Curcuma longa

Plant Name	Percentage yield (%)	
	Pet. ether	Methanol
Curcuma longa	1.21	2.72

Phytochemical Analysis

Qualitative phytochemical testing of extracts was done to study the presence or absence of various phytochemical constituents using standard tests (Kokate *et al.*, 1993). The results of Curcuma longaare shown in table.

Table 3: Phytochemical evaluations of different extracts of *Curcuma longa*

S. No.	Experiment	Results	
		Pet Ether Extract	Methanolic extract
	Test for Carbohydrates		
1	Molisch's Test	-ve	-ve
2	Fehling's Test	-ve	-ve
3	Benedict's Test	-ve	-ve
	Test for Protein & Amino acids		
4	Biuret's Test	-ve	-ve
5	Ninhydrin Test	-ve	-ve
	Test for Glycosides		
6	BorntragerTest	-ve	+ve
7	Killer killaniTest	-ve	+ve
	Test for Alkaloids		
8	Mayer's Test	-ve	+ve
9	Hager's Test	-ve	+ve
10	Wagner's Test	-ve	+ve
	Test for Saponins		
11	Froth Test	+ve	+ve
	Test for Flavonoids		
12	Lead acetate	-ve	+ve
13	Alkaline reagent test	-ve	+ve
	Test for Triterpenoids and Steroids		
14	Libermann-Burchard Test	-ve	+ve
15	Salkowski Test	-ve	+ve
	Test for Tannin and Phenolic Compounds		
16	Ferric Chloride Test	-ve	+ve
17	Gelatin Test	+ve	+ve
18	Lead Acetate Test	+ve	+ve

Isolation of Components:

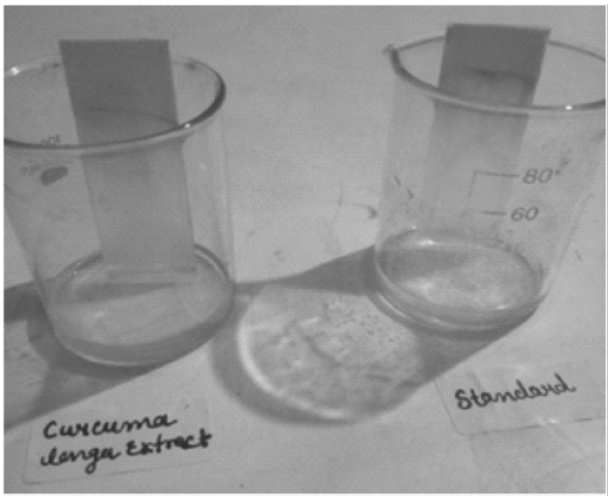


Fig. 1: TLC Plates



Fig. 2: Column chromatography of *Curcuma longa*

Preformulation Studies

The preformulation study was performed in order to assure the authenticity of sample drug and determination of some parameters for development of formulation.

Preparation of Calibration Curve

Table 4: Absorbance of curcumin at different concentrations

S. No.	Concentration (?g/mL)	Absorbance
1	1	0.361
2	2	0.538
3	3	0.725
4	4	0.964
5	5	1.348

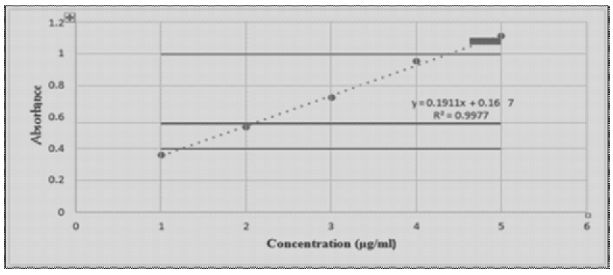


Fig. 3: Standard curve of Curcumin in ethanol

UV analysis

After scanning for λmax over a range of 300-500 nm on a double beam UV Spectrophotometer. The maximum absorbance of curcumin in ethanol was found to be at λmax 424 nm which was matched with reference indicated that the drug sample was pure.

Investigation of Physicochemical Characteristics of Curcumin:

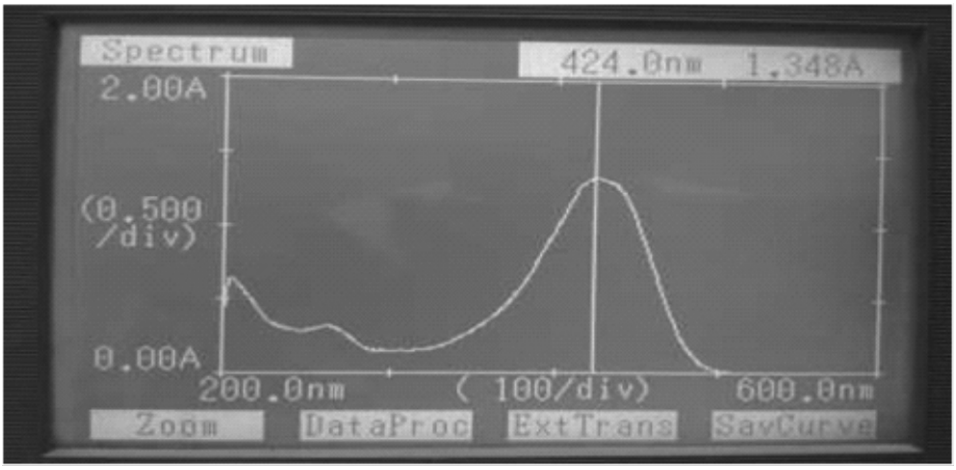


Fig. 4: Spectrum (λmax – 424nm) of curcumin in ethanol

Organolepticcharacteristics

Curcumin shows yellow in colour, pungent odor and bitter in taste

Melting point: Melting point of curcumin was found to be181±3°C were compared with standard 183°C

Evaluation parameters of transdermal patches

Physical appearance: Prepared transdermal patch was found to be yellowish color, having sufficient flexibility and smooth appearance on physicalevaluation.

Thickness: Thickness of patch was calculated by digital Vernier caliper. Thickness of FC3 was found to be 0.238±0.1087 mm, have low standard deviation value that ensures uniformity in thickness and distribution of polymer, drug and other excipients of formulations.

Weight variation: Weight of different patches of formulation (FC3) found to be 729.312±3.2113 mg, showed low standard deviationvalue.

Percentage moisture loss: It is similar to moisture content test, done to assess the physical stability of patches in dry condition. The percentage moisture loss patch was found to be 4.913±0.279 in first 24 h, reflecting low moistureloss.

Table 5: Moisture loss of formulation calculated as mean±SD

S. No	Formulation Code	Moisture loss after 12 hrs. (%±SD)	Moisture loss after 24 hrs. (%±SD)	Moisture loss after 48 hrs. (%±SD)
1	FC3	2.261±0.185	4.913±0.279	6.213±0.159

Water vapour permeation test

The water vapor permeation for prepared patches have low, these results indicates that all the formulations are permeable to water vapor.

Table 6: Water vapour permeation through patch calculated as mean±SD

S. NO.	Formulation code	WVP (gmm/cm^2) after 24 h	WVP (gmm/cm^2) after 48 h	WVP (gmm/cm^2) after 72 h
1	FC3	0.0071±0.0001	0.0215±0.000451	0.0359±0.0030

Drug content

The drug content was determined by spectrometric method. All formulation have showed that a near uniform drug content ranging from 83.0018±1.31% to 94.5172±0.73% and low standard deviations. This study revealed that the process employed to prepare the transdermal patches were capable of affording uniform drug distribution within formulations and uniform drugcontent.

Table 7: Drug content of prepared transdermal patches

S. No	Formulation code	Drug content (%±SD)
1	FC1	93±0.92
2	FC2	92±1.53
3	FC3	93±1.14
4	FC4	94±0.89
5	FC5	95±0.56

In-Vitro Drug Release Studies

On the data obtained from *in-vitro* release formulation FC3 shows sustained and controlled release as well as have high release among all other formulations, therefore formulation FC3 were further evaluated for Physicochemical properties (such as thickness, weight variation, moisture content, moisture loss, moisture uptake, water vapour permeation, drug content, mechanical properties (Tensile strength and % elongation) and animal studies (Skin irritation,Anti-inflammatory).

Table 8: Cumulative % drug release of formulation (FC1 to FC3) which contains propylene glycol as permeation enhancer and Glycerol as plasticizer.

S. No.	Time (h)	FC1	FC2	FC3	FC4	FC5
1	0	0	0	0	0	0
2	1	3.461±0.224	4.251±0.177	3.611±0.478	2.268±0.273	2.902±0.344
3	2	7.532±0.322	5.265±0.327	6.609±0.281	6.4844±0.778	4.919±0.495
4	3	11.369±0.537	7.914±0.328	9.951±0.521	10.252±0.465	6.320±0.275
5	4	14.651±0.350	11.219±0.507	12.403±0.858	13.658±0.428	7.255±0.189
6	5	16.256±0.657	13.999±0.907	15.259±0.186	15.273±0.692	8.915±0.377
7	6	18.282±0.348	16.510±0.356	17.460±0.357	16.993±0.613	9.232±0.346
8	7	21.232±0.306	18.620±0.642	19.920±0.540	17.213±0.467	10.065±0.790
9	8	22.549±0.389	21.231±0.644	22.246±0.438	21.417±0.713	13.382±0.594
10	9	24.756±0.411	23.529±0.924	23.842±0.365	22.243±0.475	17.424±0.200
11	10	27.265±0.640	24.936±0.698	25.236±0.335	25.173±0.326	22.363±0.629
12	11	32.659±0.502	26.518±0.429	27.737±0.775	27.104±0.424	25.923±0.208
13	12	38.235±0.730	30.741±0.719	30.497±0.881	29.571±0.661	26.613±0.258
14	24	64.526±0.436	45.841±0.668	47.969±0.419	40.455±0.385	32.614±0.218

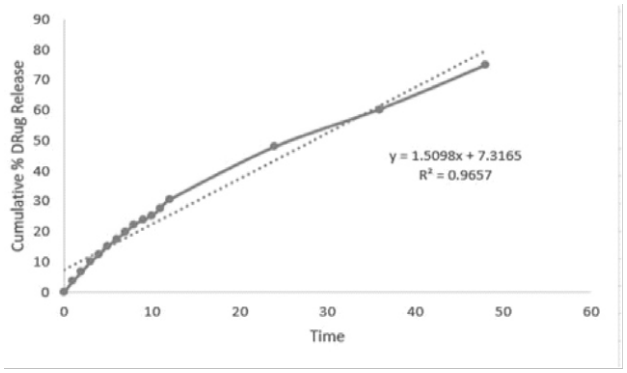


Fig. 5: Zero order release graph of formulation FC3 in Ethanol and PBS (50:50)

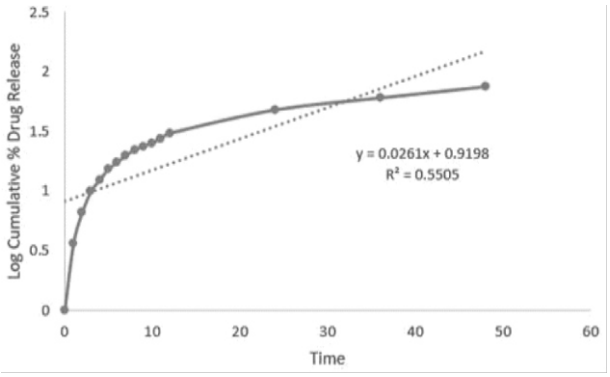


Fig. 6: First order release graph of Formulation FC3 in Ethanol and PBS (50:50)

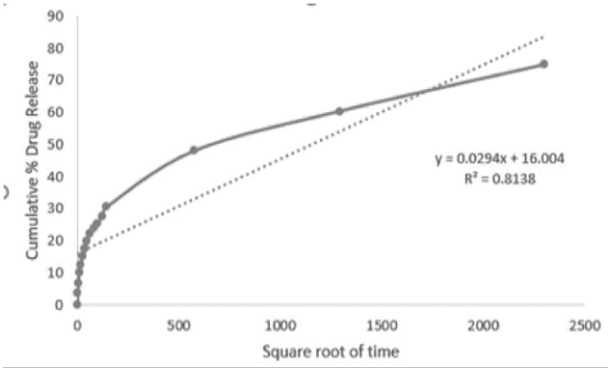


Fig. 7: Higuchi release graph of formulation FC3 in Ethanol and PBS (50:50)

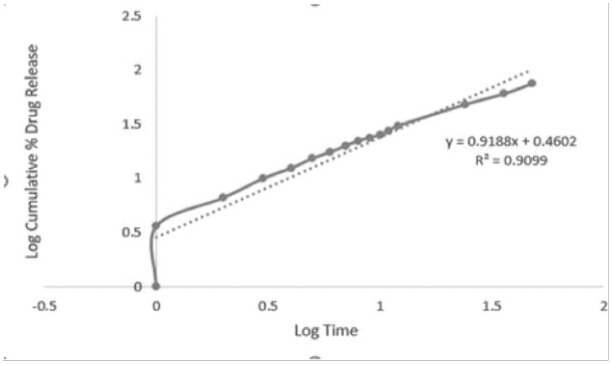


Fig. 8: Korsemeyer'sPeppas release graph of formulation FC3 in Ethanol and PBS (50:50)

5.6. *In vivo* Anti inflammatory Activity

Carrageenan-induced acute inflammation is one of the most suitable test procedures to screen anti-inflammatory agents. Carrageenan-induced paw edema model in rats is known to be sensitive to cyclo-oxygenase inhibitors and has been used to evaluate the effect of non-steroidal anti-inflammatory agents, which primarily inhibit the cyclo-oxygenase involved in prostaglandin synthesis.

Table 9: Anti inflammatory efficacy of transdermal patches using carrageen induced hind paw oedema in rats

Group No.	Treatment	Time (min.)						
		15 min	45 min	90 min	60 min	4 hr	6 hr	12 hr
I	Control	2.02±0.260	2.35±0.091	2.46±0.129	2.54±0.143	2.56±0.167	2.68±0.140	2.84±0.122
II	Standard (Indomethacin)	2.00±0.167	2.15±0.113	1.62±0.178	1.11±0.071	1.00±0.085	0.79±0.172	0.59±0.145
III	Curcumin (400 mg/kg)	2.10±0.092	2.35±0.096	2.70±0.138	2.78±0.125	2.57±0.077	1.83±0.247	1.37±0.196
IV	Formulation (20 mg)	2.07±0.181	2.44±0.129	2.54±0.119	2.45±0.083	2.06±0.063	1.67±0.124	1.07±0.154
V	Formulation (40 mg)	2.03±0.072	2.22±0.126	2.43±0.130	2.46±0.093	2.03±0.131	1.58±0.260	0.91±0.182

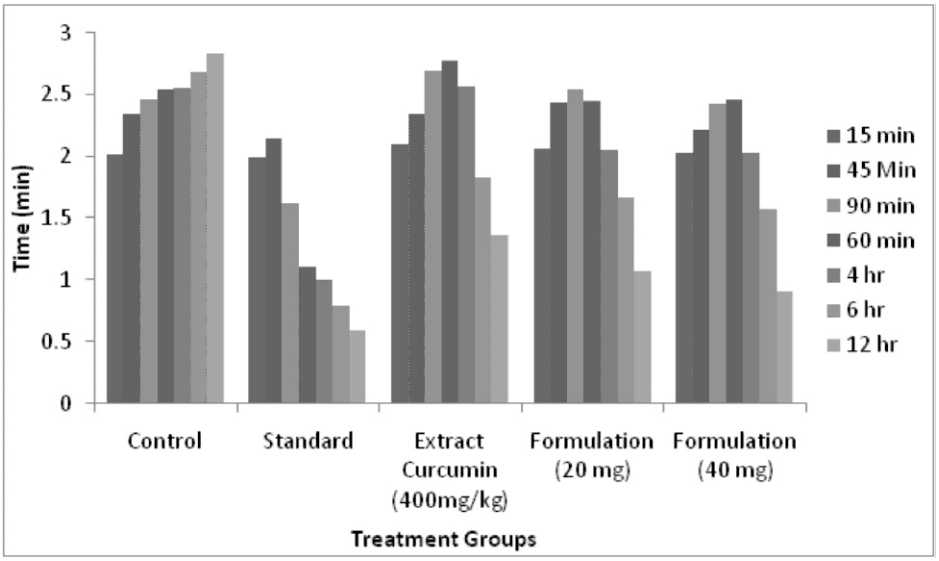


Fig. 9: Effect of anti inflammatory activity of transdermal patches using carrageen induced paw oedema technique.

CONCLUSION

Suitable parameters for the phytochemical screening, physicochemical characterization, preformulation of transdermal patches, *in-vitro* drug release and *in-vivo* anti-inflammatory activities of formulated transdermal were evaluated. The anti-inflammatory activity decreased with increasing time in case of control (Indomethacine) group whereas the curcumin (400 mg/kg) shows maximum activity at maximum time (12 h) the activity increasing with increasing time intervals. Formulation with 40 mg/kg is better than formulation 20 mg/kg. Curmuminshowed maximum activity compared to other formulation and standard.

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Serum Calcium and Phosphorus Levels In Relation to Age and Bone Health

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ABSTRACT

Globally the health standards are being increased in the modern age and lead to increase in substantial number of elderly people with the increased life expectancy and correspondingly age-related problems especially bone health. In this regard, the study was conducted to assess bone health through Quantitative Ultrasound (QUS) bone densitometry and analyze serum calcium and phosphorus levels in South Indian rural women. The investigation was also aimed at arriving age-related changes for which women of 35 to 74 years were sub-grouped into young, middle age, aged and elderly. The study results demonstrated definite decline in bone mass with advancing age with overall prevalence of 34 percent osteopenia and 29 percent osteoporosis and none of elderly women had normal bone mass. On the other hand the serum calcium and phosphorus levels are lowered with the progressive age and also as the bone density regressed from normal to osteopenia and osteoporosis.

KEYWORDS: Bone Health, Serum Calcium, Serum Phosphorus, Rural Women, India

INTRODUCTION

The role of calcium and phosphorus is very crucial in the skeletal system as the bone typically made up of hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$]. Calcium occupies the major abundant portion about 99 percent including bone and teeth. The remaining one percent is found in the serum within tight limits by the effective fundamental biological and metabolic processes. Calcium metabolism is integrated with certain other nutrients especially pss and accelerates the prognosis of osteoporosis in elderly. Vitamin D play a crucial role in regulating blood calcium levels as the active form of calcitriol and is responsible for dimerization of Vitamin D receptor by triggering the appropriate metabolic functioning of intestines, kidneys and bones. Vitamin D can be accessed well from the diet or obtained from the 7-dehydrocholesterol which is present under the skin and gets activated in the presence of sunlight. However, the interesting fact that to the maximum extent serum levels are maintained within normal range. The bone health management should be focused on effective measures those lower the risk of bone loss and to minimizing the high risk conditions of either declined serum calcium (hypocalcaemia) or elevated levels (hypercalcemia) where the two extremities are the indications of severe bone losses in the body (Bhattarai *et al*., 2020).

Osteoporosis is a major health problem threatening the public bone health worldwide. Asian women especially are affected and in India the exact picture on the prevalence of the disease is not well established but on an average one in four women above the age of 50 years believed to be suffered from the bone deteriorating problem. Calcium and Vitamin D supplementation is well recognized as the first line intervention approach in the management of osteoporosis. This reflects the importance of calcium in the bone metabolism and in fact the bone tissue is majorly made of calcium and phosphorus (Khadilkar and Kajale, 2013). Based on this background the current research was aimed at assessing the bone health among rural women of South India and to find out the changes in serum calcium and phosphorus levels in relation to bone health evaluation as normal, osteopenia and osteoporosis.

MATERIALS AND METHODS

The study was conducted in the rural areas of Chittoor district located nearby to Tirupati town among women in the age range of 35 to 74 years. The sample was further subdivided into four different age groups viz., 35 to 44 years (young), 45 to 54 years (middle age), 55 to 64 years (aged) and 65 to 74 year (elderly) to study age-related changes in biochemical markers of serum calcium and phosphorus in relation to bone health in terms of

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Bone Mineral Density (BMD). The sample comprised of 60 young, 80 each of middle age and aged and 40 elderly women with a total size of 260 rural women.

Bone health was evaluated through Quantitative Ultrasound (QUS) bone densitometry measured at calcaneus bone. World Health Organization (WHO) classification of BMD T-score was considered for assessment of osteopenia (BMD T-Score: -1.0 to -2.5) and osteoporosis (BMD T-Score: ≤ -2.5) (Hans *et al*., 1996). The evaluation was carried out at the local orthopedic hospitals during BMD campaigns and intimation was conveyed to the target group after receiving confirmation from the hospital authorities and mobilized to attend the BMD analysis. Meanwhile the serum was also collected from the subjects to estimate the biochemical markers of serum calcium and serum phosphorus using standard protocols through automated analyzer.

RESULTS AND DISCUSSIONS

The data gathered from the selected rural women was interpreted and illustrated in terms of bone health status and biochemical markers of serum calcium and phosphorus. The bone health was evaluated based on WHO criteria of BMD T-scores standard deviations and accordingly the women were categorized into normal, osteopenia and osteoporosis. The results thus obtained were discussed further under different subheads.

Bone Health Status

The bone health status was analyzed through frequency distribution by considering the number of women affected by osteopenia and osteoporosis in each age group. Based on the frequency distribution and the corresponding sample size of the respective age group, the percent values were calculated. Even the overall low and poor bone density conditions were estimated by considering both osteopenic and osteoporotic women to predict the percent of women deviated from the normal bone mass of each age group. The data was also evaluated for the total sample size to express the total prevalence of osteopenia and osteoporosis in the selected rural women. The distribution of women belonging to four different age groups was expressed as frequency distribution and the corresponding percent values and presented in table1.

Table 1 Distribution of osteopenia and osteoporosis among rural women of different age groups

Group	Frequency (%)			
Age (Years)	Normal	Osteopenia	Osteoporosis	Osteopenia+ Osteoporosis
Young 35-44 (n = 60)	37 (62)	17 (28)	6 (10)	23 (38)
Middle Age 45-54 (n = 80)	37 (46)	30 (38)	13 (16)	43 (54)
Aged 55-64 (n = 80)	23 (29)	32 (40)	25 (31)	57 (71)
Elderly 65-74 (n = 40)	Nil	10 (25)	30 (75)	40 (100)
Total (n=260)	97 (37)	89 (34)	74 (29)	163 (63)

Note: Values within parentheses indicate percent values

The percent distribution from the table 1 denoted that the normal bone density condition seemed to be lowered from young (63 percent) to aged rural women (29 percent) and none of the elderly women had normal bone density. The osteopenic condition found to be increased with the advancing age from the prevalence of 25 percent to 40 percent in the different age groups. Later the percent prevalence of osteopenia was reduced to 25 percent in elderly rural women as three fourth of them were affected by severe bone loss condition of osteoporosis (75 percent). On the other hand the prevalence of osteoporosis had increased from 10 percent to 75 percent with the progressive age.

The bone densities are relatively lower in both the conditions of osteopenia and osteoporosis which

need to be considered by initiating preventive measures at normal bone status, curative measures at osteopenia and further effective integrated intervention approaches to minimize the risk of osteoporosis. When considered both conditions, slightly above one third of the young rural women (38 percent), half of the middle age (54 percent) and slightly lower than three fourth (71 percent) of aged women and absolutely all the elderly experienced either from osteopenia or osteoporosis. The overall prevalence of osteopenia was 34 percent and osteoporosis about 29 percent and all together 63 percent of the selected rural women in the age range of 35 to 74 years suffered from either low (osteopenia) or poor (osteoporosis) bone mineral density.

Binu *et al*., 2019 denoted similar trend of results with the rise in the incidence of postmenopausal osteoporosis with advancing age. The prevalence of osteoporosis was noted as 22 percent at the site of femoral neck and 39 percent at the site of lumbar spine when evaluated through dual energy X-ray absorptiometry. Similarly in another study also indicated the high prevalence of 32.47 percent osteoporosis between ages of 20 and 76 years among female population of rural central India measured at heel by ultrasound (Nikose *et al*, 2015).

Serum calcium levels in relation to bone health

The present study was focused on analyzing the changes of serum calcium levels in association with the bone health status as compared against normal, osteopenic and osteoporotic women of each age group. The levels of differences in the changes of bone densities were interpreted statistically by finding out the relationship between the serum calcium values through calculated t- values viz., normal vs osteopenia, normal vs osteoporosis and osteopenia vs osteoporosis. The mean serum calcium values thus estimated in relation to bone health were depicted in table 2.

Table 2 Mean serum calcium levels in relation to bone health among rural women of different age groups

Group	Mean serum calcium(mg/dl)			Calculated t-values		
Age (Years)	Normal Mean & ± S.D	Osteopenia Mean & ± S.D	Osteoporosis Mean & ± S.D	Normal Vs Osteopenia	Normal Vs Osteoporosis	Osteopenia Vs Osteoporosis
Young 35-44 (n=60)	10.11 ± (0.29)	9.88 ± (0.35)	9.64 ± (0.27)	2.60*	3.73**	1.51 ^{NS}
Middle Age 45-54 (n = 80)	9.68 ± (0.31)	9.47 ± (0.28)	9.36 ± (0.17)	2.88**	3.47**	1.27 ^{NS}
Aged 55-64 (n = 80)	9.38 ± (0.25)	9.31 ± (0.16)	9.22 ± (0.17)	1.30NS	2.74**	2.11*
Elderly 65-74 (n = 40)	Nil	9.25 ± (0.09)	9.18 ± (0.11)	Nil	Nil	1.71 ^{NS}

Reference values: 9 to 11 mg/dl

*= Significant at 5 percent level **= Significant at 1 percent level NS = Not Significant

The data from the table 2 represented that the mean serum calcium levels found to be lowered from young to elderly irrespective of bone health status. The most important point to be highlighted that the serum calcium values seemed to be within normal range of 9 to 11 mg/dl. The homeostasis mechanism involved is that in spite of progressive age-related accelerated calcium loss, the serum calcium levels are maintained by drawing calcium from the bones into the blood during declined conditions (Fazlini *et al* (2013). Because skeleton acts as bank for the calcium where the blood can easily borrow calcium from the bone marrow whenever needed. The situation well explained the basic requirement of adequate dietary calcium intakes, otherwise much of the bone calcium reserves will be drawn leading to appearance of osteopenia and further to osteoporosis resulting in more porous and fragile bones.

The results on serum calcium revealed a significant decrease from normal to osteopenia in young and middle age women but the reduction was not at significant level in aged probably due to the reason of associated lowered serum levels even in normal bone density individuals. The comparative levels

between normal and osteoporotic women found to be highly significant at one percent levels in young, middle and aged rural women indicating significant calcium loss as the bone density regressed from normal to osteoporotic bone within the narrow normal limits of serum calcium. None of the elderly rural women had normal bone density for comparison as they experienced the bone health problem of either osteopenia or osteoporosis. The serum calcium levels observed to be reduced from osteopenic to osteoporotic women but the differences were not significant except in aged women probably due to relatively higher losses at slightly higher pace from the age of 55 years. The non-significant differences in elderly women might be due to existing lower range of serum calcium values among osteopenic women which continued to be maintained in those narrow limits.

One of the recent study carried out by Himabindu, 2019 also indicated the existence of low bone densities in post-menopausal women with the incidence of 1.6 percent normal, 21.6 percent of osteopenia and 76.66 percent of osteoporosis. Similar to the present study, there was positive correlation between serum calcium levels and bone mineral density.

Serum phosphorus levels in relation to bone health

Similar to that of serum calcium values, the mean serum phosphorus levels were also expressed in terms of bone health condition of normal, osteopenia and osteoporosis of each age group. The differences were shown statistically through calculated t-values and tabulated in table 3.

Table 3 : Mean serum phosphorus levels in relation to bone health among rural women of different age groups

Group	Mean serum phosphorus(mg/dl)			Calculated t-values		
Age (Years)	Normal Mean & ± S.D	Osteopenia Mean & ± S.D	Osteoporosis Mean & ± S.D	Normal Vs Osteopenia	Normal Vs Osteoporosis	Osteopenia Vs Osteoporosis
Young 35-44 (n=60)	3.96 ± (0.29)	3.77 ± (0.44)	3.58 ± (0.53)	1.87 NS	2.63**	0.88 NS
Middle Age 45-54 (n = 80)	3.76 ± (0.44)	3.62 ± (0.37)	3.51 ± (0.30)	1.38 NS	1.96 NS	1.01 NS
Aged 55-64 (n = 80)	3.57 ± (0.38)	3.50 ± (0.34)	3.39 ± (0.30)	0.73 NS	1.88NS	1.30NS
Elderly 65-74 (n = 40)	Nil	3.42 ± (0.41)	3.29 ± (0.20)	Nil	Nil	1.39 NS

Reference values: 2.5 to 4.5 mg/dl
*= Significant at 5 percent level **= Significant at 1 percent level NS = Not Significant

The findings from the table 3 also implicated that similar to that of serum calcium levels, a decline in serum phosphorus levels were noticed to be lowered from younger to elderly rural women within tightly regulated normal reference values of 2.5 to 4.5 mg/dl. The major mechanism behind this direct association was mainly attributed that the two essential minerals work in cohort intricately in metabolic and regulation processes concerned to bone remodeling process and metabolism. The other probable factor was the non-evidence of phosphorus deficiency as the optimal supply of phosphorus commonly obtained from the usual diets.

The interesting point to be stressed that the mean serum phosphorus levels varied within the age group from normal to osteopenia and still worsen with the proceeding worsening condition of osteoporosis within normal values. But the differences were not significantly different except between normal and osteoporotic young women indicating slighter variations of phosphorus only and are little affected with the lowered bone density conditions of both osteopenia and osteoporosis. The condition indicated greater alterations with the serum calcium levels rather than serum phosphorus. However, the trend of results strongly evidenced that both serum calcium and phosphorus were lowered with the advancing age and with the shift from normal to osteopenia and further to osteoporosis in spite of

effective regulatory mechanisms involved to maintain within the normal standard reference ranges.

The current research findings also coincided with the cross-sectional study conducted by Shakoor *et al*., 2014 with the reduction in both serum calcium and phosphorus with the advancing age as well as while the bone health regressed from normal to low bone density condition of osteopenia and in turn a shift towards poor bone density condition of osteoporosis. They carried out research in thirty postmenopausal women to identify the prevalence of osteoporosis and studied for the relationship with body mass index, body fat, muscle mass and the levels of calcium and phosphorus in the serum. The results indicated by significant decline in body weight, muscle mass and serum calcium and phosphorus with increasing age and observed no significant association with body mass index and height.

CONCLUSION

The study was emphasised on evaluating bone health status in South Indian rural women and evaluated the relationship with serum calcium and phosphorus levels. The findings clearly demonstrated gradual decline in bone mineral density and simultaneously both the biochemical markers analysed with the advancing age. However, the serum calcium and phosphorus levels were tightly regulated within the normal reference ranges. This particular scenario strongly indicated the diet need of maintaining the calcium intakes to prevent the bone calcium loss for maintaining serum calcium levels and restore bone mass effectively.

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Price Dynamics of Tur in Major Markets of Karnataka.

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ABSTRACT

Agriculture occupies the central place in rural life. It is rightly said that agriculture is considered as the back bone of the Indian economy. Demand for pulses is increasing day to day as it is the rich source of proteins. Among pulses pigeon pea which is also called as tur is one of the major pulse. The time series data pertaining to prices and arrivals for the respective markets were collected for the period from January 2005 to October 2020. Auto regressive integrated moving average method is employed to forecast the prices of tur in the selected major markets. Seasonal Indices and forecasts revealed there is an increasing trend of prices

Key Words : Pulses, ARIMA, Forecasts, Policy, Awareness.

INTRODUCTION

The words of Mr. Jawaharlal Nehru, “Everything else can wait, but not agriculture” are true even today, as agriculture continues to be the most crucial sector of the Indian economy. Agriculture provides employment to major people as well as it is also key sector for the Indian economy. A variety of crops are grown in India. Pulses are rich in protein. Among pulses, redgram (Cajanuscajan) is one of the important pulse crop. Redgram is aperennial legume from the family Fabaceae. Redgram is commonly known as Tur or Arhar in India and is the second important pulse in the country after gram (chana). The ability of redgram to produce high economic yields under soil moisture deficit makes it an important crop in rainfed and dry land agriculture. India contributes for nearly 90% of world's total redgram production.The average yield of pulses in India is about 735 kg/hectare. In the rainy season, pulses like pigeon pea, green gram, black gram and cow pea are the most important and leading pulse crops of India. Major growing areas of pulses in India are Madhya Pradesh, Uttar Pradesh, Gujarat, Maharashtra, Karnataka and Rajasthan. Madhya Pradesh is the leading state in India in pulses, in terms of cultivated area and productivity(Ashwini et.al 2017). The paper attempts to study the seasonal indices and price forecasts of tur in the major markets of North Karnataka.

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METHODOLOGY

The study on price forecasts and seasonal indices was calculated for the major markets of Tur of North Karnataka which was selected by taking three years average of price. Of which Kalaburagi, Bidar and Raichur were the three major markets of Tur. The time series data pertaining to prices and arrivals for the respective markets were collected for the period from January 2005 to October 2020. Data used for the study was collected from Krishimarthavahini website.

Seasonal indices

To measure the seasonal variations in prices, seasonal indices were calculated employing twelve months ratio to moving average method. The seasonal indices were calculated by adopting the following steps: In the first step, 12 months moving total were generated. These totals were divided by 12 to compute 12 months moving average. Then a series of centered moving averages were worked out. In the next step, original values were expressed as a percentage of corresponding centered moving averages. Further, the irregular component in the series was removed. Afterwards, these percentages were arranged in terms of monthly averages. Then the average index for each month was computed. Finally these monthly average indices were adjusted in such a way that their sum becomes 1200.

This can be done by working out a correction factor

and multiplying the average for each month by this correction factor. The correction factor (K) is worked out as follows.

$$K = 1200/ S$$

Where, K is correction factor and S is sum of averages of indices for 12 months, multiply K with the percentage of moving average for each month to obtain the seasonal indices.

ARIMA

ARIMA (p,d,q): ARIMA models are, in theory, the most general class of models for forecasting a time series which can be stationeries by transformations such as differencing and lagging. In fact, the easiest way to think of ARIMA models is as fine-tuned versions of random-walk and random-trend models: the fine-tuning consists of adding lags of the differenced series and/or lags of the forecast errors to the prediction equation, as needed to remove any last traces of autocorrelation from the forecast errors.

The acronym ARIMA stands for "Auto-Regressive Integrated Moving Average". Lags of the differenced series appearing in the forecasting equation are called "auto-regressive" terms, lags of the forecast errors are called "moving average" terms, and a time series which needs to be differenced to be made stationary is said to be an "integrated" version of a stationary series. Random-walk and random-trend models, autoregressive models and exponential smoothing models (i.e., exponential weighted moving averages) are all special cases of ARIMA models.

A non seasonal ARIMA model is classified as an "ARIMA (p, d, q)" model, where:

- p is the number of autoregressive terms,
- d is the number of non seasonal differences, and
- q is the number of lagged forecast errors in the prediction equation.

To identify the appropriate ARIMA model for a time series, one should begin by identifying the order(s) of differencing, needing to stationarise the series and remove the gross features of seasonality, perhaps in conjunction with a variance-stabilizing transformation such as lagging or deflating. If one stops at this point and predicts that the differenced series is constant, one has merely fitted a random walk or random trend model. However, the best random walk or random trend model may still have auto correlated errors, suggesting that additional factors of some kind are needed in the prediction equation. The similar method was used by Seyed J S ,2015.

RESULTS AND DISCUSSION

Table 1 depicts the actual and forecasted prices of tur in the Raichur market. In the month of January 2018 the price of tur was around Rs 4367 per quintal and it has reached Rs 4527 per quintal in December 2018. It was observed from the table that price of tur per quintal was observed to be Rs 6476 in the month of October, 2020. The forecasted values indicate there will be rise in price of tur in Raichur market from December 2020 crossing Rs 7000 around per quintal. The price of tur is having the increasing trend in till April 2021, and there after the model has indicated there will be decreasing trend. Table also depicts the validation of the forecasting model from January 2018 to October 2020. It can be observed that the validation is in between the range of 99.81 per cent to 73.89 per cent value. For the year of 2020 the validation of forecasted values were around in the range of above 90 per cent only. It can be observed that accuracy of forecasts were to the tune of 98.10 per cent for the value of June 2020 indicating the model of ARIMA 111 is best model for the forecasts. Similar observations were made by Changule ,2012.

Table 2 shows the actual and forecasted prices of tur in the Kalaburagi market. It is observed from the table that the price of tur in the month of January, 2018 was Rs 4172 per quintal which has reached Rs 4761 per quintal in the month of December 2018.The price of tur was around Rs 7613 per quintal in the month of October, 2020. The forecasts value indicate the prices are expected to be increase from January 2021 crossing the value of Rs 8000 per quintal in the month of October 2021.Validation of the forecasts indicated that, accuracy of the forecasts were to the tune of 99.59 per cent which was observed for the month of January,2018. For the year 2020, validations of forecasts were in the range of 83 per cent to 99.10. Highest accuracy of forecasts were seen for the Month of August, 2020 with 99.10 per cent. Forecasts were found to be best in the ARIMA 101 which was higher accuracy of the forecasts.

Actual and forecasted prices of Tur in Bidar market can be observed in table no 3. Actual price of tur which was Rs 4249 per quintal in the month of Janaury 2018 has now reached Rs 4583 per quintal in December 2018. Per quintal of tur price was around Rs 7146 for the month of October, 2020. The forecasts value indicate that the prices of Tur is going to increase and is expected to reach Rs 7933 per quintal in the month of Sepetmber 2021.Validation of the forecasts indicate that the prices which were forecasted are accurate to the tune of 99.74 per cent. Range of validation was between 71.91 per cent to

99.74 per cent which was found to be best in ARIMA 101 model.For the year 2020 the validation of the prices for ten months was more than 90 per cent, highest accuracy was found for the month of January 2020, with the value of 99.54 per cent. The overall results obtained were on par with Kiran Kumar *et,al*.

Table No.4 presents the seasonal indices of prices of tur in Raichur, Kalaburagi and Bidar market. It can be observed from the table that the seasonal indices for the prices of Kalabuaragi was found to be more in the months of November (104.04), December (106.66), January (100.82), March (106.45) , April (102.89), May (102.51) and June (101.35) indicating the prices of tur will be high in these months. Prices will be low in the months of July (95.85), August (97.55), September(91.26) and October with a seasonal index value of 92.34. Seasonal indices of prices in Kalaburagi market indicated that the prices of Tur will be more in the months of July (102.82), August(106.57), September(106.25), October (111.78), November (104.74) and December (100.13). Prices will be low in the months of January (91.44), February (91.72), March (92.87), April (96.27), May (97.51) and index of June was found to be 97.87.Resulst obtained were on par with Choudhary, 2010. It can be observed from the table that seasonal indices of prices of Tur in Kalaburagi and Bidar market are quiet similar since price variation in one market has direct effect on the another market which is mainly due to the close proximity between the markets.

CONCLUSION

Market information dissemination may be geared up in order to create the awareness about the trends in current and future prices in the regulated markets. Creation of awareness among the farmers to bring the produce in respective months of high price which will result in realizing better prices for their produce. Government may take the policy decisions for increasing the dissemination of information to the farmers in the larger extent since tur is one of the important and highly profitable produce.

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Table 1. Actual and Price forecasts of Tur in Raichur Market

Year	Months	Actual Price	Forecasted Price	Validation
2018	January	4367	4408	99.06
	February	4365	4270	97.78
	March	4012	4761	84.28
	April	4086	4002	97.91
	May	4142	3982	95.98
	June	4030	4038	99.81
	July	3932	3767	95.63
	August	3689	3896	94.68
	September	3371	3587	93.99
	October	3384	3243	95.66
	November	3217	3444	93.42
	December	4527	4173	91.51
2019	January	5478	4344	73.89
	February	5710	5260	91.45
	March	5267	6019	87.51
	April	5244	5257	99.76
	May	5264	5139	97.56
	June	5117	5149	99.37
	July	4969	4893	98.44
	August	4746	4997	94.97
	September	4069	4584	88.77
	October	4106	3979	96.82
	November	4495	4159	91.92
	December	5247	5398	97.21
2020	January	5037	5150	97.80
	February	5056	4958	98.02
	March	4788	5322	89.97
	April	5368	4777	87.63
	May	5033	5227	96.29
	June	5045	4951	98.10
	July	5274	4827	90.74
	August	5361	5240	97.69
	September	5846	5146	86.39
	October	6476	5662	85.62
	November		6450	
	December		7422	
2021	January		7416	
	February		7361	
	March		7568	
	April		7518	
	May		7446	
	June		7346	
	July		7149	
	August		7140	
	September		6899	
	October		6806	
	November		6894	
	December		6849	

Table 2. Actual and Price forecasts of Tur in Kalaburagi Market

Year	Months	Actual Price	Forecasted Price	Validation
2018	January	4172	4155	99.59
	February	4110	4166	98.65
	March	3842	4093	93.88
	April	3773	4030	93.62
	May	3965	3845	96.89
	June	3751	3921	95.66
	July	3780	3906	96.78
	August	3793	4023	94.29
	September	3659	3883	94.22
	October	3573	3978	89.82
	November	4406	2900	48.07
	December	4761	4350	90.54
2019	January	4970	4587	91.64
	February	5127	4873	94.79
	March	4889	5036	97.08
	April	5106	5043	98.75
	May	5765	5151	88.07
	June	5641	5592	99.13
	July	5701	5770	98.80
	August	5693	5849	97.33
	September	5432	5777	94.03
	October	5303	5787	91.64
	November	5524	4843	85.94
	December	5239	5679	92.26
2020	January	4725	5303	89.11
	February	4813	4873	98.76
	March	4843	4762	98.29
	April	5159	4972	96.24
	May	5099	5274	96.68
	June	5296	5119	96.54
	July	5732	5372	93.31
	August	5823	5771	99.10
	September	6415	5831	89.99
	October	7613	6515	83.15
	November		6813	
	December		7062	
2021	January		6898	
	February		6923	
	March		6903	
	April		7076	
	May		7154	
	June		7176	
	July		7361	
	August		7488	
	September		7626	
	October		8064	
	November		7403	
	December		7676	

Table 3. Actual and Price forecasts of Tur in Bidar Market

Year	Months	Actual Price	Forecasted Price	Validation
2018	January	4249	4768	89.11
	February	4188	4231	98.99
	March	3914	4195	93.30
	April	3818	4071	93.78
	May	3954	3781	95.42
	June	3707	4035	91.88
	July	3733	3864	96.62
	August	3693	3606	97.58
	September	3583	3808	94.09
	October	3521	3630	96.99
	November	4331	3381	71.91
	December	4582	4086	87.87
2019	January	5006	4703	93.57
	February	5104	5036	98.65
	March	4922	5215	94.37
	April	5173	5150	99.54
	May	5712	5170	89.52
	June	5524	5828	94.78
	July	5419	5742	94.38
	August	5502	5488	99.74
	September	5178	5590	92.63
	October	4883	5201	93.88
	November	4954	4676	94.05
	December	4916	4825	98.11
2020	January	4834	4857	99.54
	February	4905	4783	97.46
	March	4816	4938	97.53
	April	5199	4954	95.06
	May	5081	5144	98.77
	June	5247	5125	97.61
	July	5536	5455	98.52
	August	5731	5595	97.57
	September	6044	5850	96.68
	October	7146	6140	83.61
	November		7205	
	December		7221	
2021	January		7321	
	February		7347	
	March		7407	
	April		7585	
	May		7671	
	June		7690	
	July		7853	
	August		7912	
	September		7933	
	October		7831	
	November		7828	
	December		7780	

Table 4. Seasonal Indices of arrivals of Tur in major markets of Karnataka

Months	Raichur	Kalaburagi	Bidar
January	100.82	91.44	93.43
February	98.31	91.72	92.94
March	106.45	92.87	94.39
April	102.89	96.27	97.14
May	102.51	97.51	98.04
June	101.35	97.87	99.35
July	95.85	102.85	103.38
August	97.55	106.57	106.79
September	91.26	106.25	103.25
October	92.34	111.78	106.65
November	104.04	104.74	105.66
December	106.66	100.13	98.99

Gujarat Agricultural Universities Research Journal

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Contents

Research Papers

Exploring Present Status of Home Science Graduates	Vatta, L., Chayal, K. And Tiwari, S.	53
Development of Yardstick of CV % for Maize Crop Experiments for Godhara Center	G.n. Motaka, X. U. Shukla And D.j. Parmar	58
Study of In *Vitro* digestion on antioxidant capacity of three different varieties of *Phoenix dactylifera*	R.v Sista And V.h Patel	63
Comparative analysis of physio-chemical parameters and effect of different juice extraction techniques on the pulp yield of nectarine cultivars	Shivani, Y.s Dhaliwal And Anita Kumari	70
Improving Blood Sugar Level of Non Insulin Dependent Diabetics with Indian Gooseberry Powder and Curcumin Powder	Priya Yadav And Ankita Gupta	78
In-vivo antiurolithiatic activity of *Thunbergia erecta*	V. Chandel, A. Choubey And S. Asati	84
Formulation and evaluation of transdermal patches of isolated compound from plant extract for in-vivo anti-inflammatory activity	S. Asati, V. Chandel, And A. Choubey	90
Serum Calcium and Phosphorus Levels In Relation to Age and Bone Health	R.bharathi	101
Price Dynamics of Tur in Major Markets of Karnataka.	Nataraj B.patted, Halaswamy D And K Vasudeva Naik	106

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