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Journal of Biotechnology and Bioengineering Research

Aims and Scope

The Journal of Biotechnology and Bioengineering Research is published quarterly by Enriched publications. Journal of Biotechnology and Bioengineering Research is peer reviewed journal and monitored by a team of reputed editorial board members. This journal consists of research articles, reviews, and case studies on Agriculture & Biotechnology. This journal mainly focuses on the latest and most common subjects of its domain.

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Bibliometric Study of Indian Journal of Biotechnology

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ABSTRACT

This paper presents a bibliometric features and characteristics of the journal titled 'Indian Journal of biotechnology'. It publishes four issues per year by NISCAIR, New Delhi. The data were downloaded from the journal's website. The Bibliometric analysis has been conducted with 448 contributions published in the journal selected six years for a period between 2007 and 2012. The analysis covers mainly discuss the each article, year wise distribution of contributions, and number of authorship, volume wise authorship, author's productivity and the single and multi-authored papers and also many more features. Findings of the studies pointed out towards the advantages and weakness of the journal which are helpful for its further development. The result revealed that the highest number of contributions i.e., 87 (19.41 %) were published in the years 2007. The highest number 436 (97.33 %) articles were contributed by joint authors and the rest of 12 (2.67 %) articles contributed by single author. The degree of collaboration is 0.97. The average length of the articles varied from a minimum of 5.94 pages in the year 2012.

Keywords: Bibliometrics; Authorship Pattern; Degree of Collaboration; Journal of Biotechnology; Indian Journal; Publication Analysis; India.

1. Introduction

The term 'Bibliometrics' defined as 'the application of mathematical and statistical methods to books and other communication medium' by Pritchard, A. (1969). Bibliometric methods are used in studies of properties and behaviour of recorded knowledge for analysis of the structures of scientific and research areas, and for evaluation of research activity and administration of scientific information. Various statistical methods are applied to study to measure, authorship, citation and publication pattern, and the relationship within scientific domains and research communities and to structure of specific fields. In this sense, bibliometrics is also relevant for researchers, policy and decision makers and also researchers outside the library and information science (LIS) field to track the trend in the specific field in their research work. Patra S.K; Bhattacharya, P & Verma, N (2006). Sengupta (1990) defined it as the "organization, classification and quantitative evolution of publication patterns of all macro and micro communications along their authorship by mathematical and statistical calculus." Bibliometrics as a

technique has extensive applications in identifying the research trends in a subject, trends in authorship and collaboration in research, core periodicals, obsolescence and dispersion of scientific literature useful in estimating the comprehensiveness of secondary periodicals, studying publications by scientists, citation studies and so on. It can also be used in the identification of emerging research areas.

Source: Indian Journal Of Biotechnology

Indian Journal of Biotechnology is a leading quarterly journal, published by the National Institute of Science Communication and Information Resources (NISCAIR), New Delhi. It is started as a quarterly journal in 2002, publishes full papers, short communications and reviews in agricultural, animal, environmental, industrial, medical, and microbial biotechnology, bioinformatics, and socio-legal and ethical aspects in biotechnology. The latest developments in biotech-industry are covered under Notes and News. Indian Journal of Biotechnology has been selected for coverage in Thomson Reuter's products and custom information services. Beginning with Volume 7 (1) 2008, information on the contents of this publication will be indexed in namely Science Citation Index Expanded (also known as SciSearch); Journal Citation Reports/Science Edition and Biotechnology Citation Index. This coverage is in addition to existing inclusion in Biological Abstracts and BIOSIS Previews. Data were collected from their website: http://www.niscair.res.in; http://nopr.niscair.res.in for analyzing and arrive its results.

Related Work

Gupta, B M; Bala, A and Kshitig, A (2013), analysed the global publications output in cataract research during 2002-11 on several parameters including contribution & citation impact of top 15 most productive countries, different types of cataract research, research output by different population age groups, subject-wise break-up of research output, relatedness of various diseases to cataract research, research contribution. The Scopus Citation Database had been used to retrieve the data for 10 years (2002-11) by searching the keywords “cataract” in the combined Title, Abstract and Keywords field. The world publication output in cataract research consisted of 27053 papers during 2002-11, which increased from 2025 papers in 2002 to 3080 papers in 2011, witnessing an annual average growth rate of 4.89%. The average citation impact per paper registered by world publications was 6.94 during 2002-11, which decreased from 7.82 during 2002-06 to 5.21 during 2007-11. Tsay (Ming-Yueh), 2011, conducted the study was to explore the journal bibliometric characteristics of the Journal of Information Science (JIS) and the subject relationship with other disciplines by citation analysis. The citation data were drawn from references of each article of JIS during 1998 and 2008. The databases like Ulrich's Periodical Directory, Library of Congress Subject Heading, retrieved from the WorldCat and LISA database were used to identify the main class, subclass and subject of cited journals and books. The

results was found that the journal articles are the most cited document, followed by books and book chapters, electronic resources, and conference proceedings, respectively.

The data were collected from the annual reports of Central Tuber Crops Research Institute (CTCRI) were studied and the results was found that the highest number of 169 papers were published in the year 2006 and the average number of publications per year was 97.82 and the most of the papers were multi authored i.e. 87.68 %. The degree of collaboration of scientists of CTCRI was 0.87 and most of the articles published by the scientists were from foreign journals i.e. 51.89 %. Sudhier K.G. P and Priyaalakshmi, V (2013). Thanuskodi S (2011) analysed the journal titled "Library Herald" for the period between 2006 and 2010. The analysis covered mainly the number of articles, authorship pattern, subject wise distribution of articles, average number of references per articles, forms of documents cited, year wise distribution of cited journals etc. it was found that all the studies point towards the merits and weakness of the journal which will be helpful for its further development. The result showed that out of 138 articles single author contributed 72 (52.17%) articles while the rest 66 (47.83%) articles were contributed by joint authors. The study revealed that most of the contributions are from India with 89.85 % and the rest 10.15 % only from foreign sources. The study investigated the papers of Rabindranath Tagore (1861–1941) received Nobel Prize for Gitanjali (Songs Offerings) in 1913 which is a collection of poems from different kavyagrantha (book of poems). The growth of poems of Gitanjali, their lengths, places and dates of writings, use of words, rank frequency of different words and to find out whether Gitanjali follows any bibliometric law. The study was found the results of the title Gitanjali with the help of bibliometric techniques. It was observed from the study that many poems of Gitanjali are songs, written long before the publication and submission of Gitanjali for Nobel Prize. Ray Partha Pratim1, Sen B.K.(2012).

Hussain, Akhtar; & Fatima, Nishat. (2011), observed that a bibliometric analysis of the Chinese Librarianship: an International Electronic Journal for the period of 2006-2010 has been conducted. The study demonstrates and elaborates on the various aspects of the Journal, such as its distribution of article by year, authorship patterns, distribution of contributions by institution, subject distributions, citation patterns, length of article, rank of cited authors, and geographical distributions of authors. It was observed the growth, contribution, and impact of research carried out by the researchers at the Orissa University of Agricultural Technology (OUAT), Bhubaneswar, India, based on the publications indexed in Scopus during 2008 to 2012. It was identified that the average annual publications range from 33 to 34 papers, with 0.96 degree of collaboration. The maximum numbers of papers were published within the 1-5 page range. OUAT, S. K. Mishra, Agricultural and Biological Sciences, and India are the most prolific institution/organization, author, subject area, and country respectively. Maharana, Rabindra K. (2013).

The study was analysed and compared twenty-one core LIS journals published between 1980 and 1999 to ascertain the research contribution of developing countries and Eastern European countries. He found that the number of articles from China, Saudi Arabia, Turkey, Botswana, Ghana, Kuwait, and Taiwan has increased considerably while those in India, Nigeria, Pakistan, Brazil, and Poland have declined. Uzun (2002). Chaurasia, Kamal Kumar. (2008) analysed and observed that the journal i.e. Annals of Library and Information Studies during the period between 2002 and 2006 which showed trend of growth in contributions and average number of contributions is 21.4 per volume. The majority of the library and information scientists prefer to do collaborative research and contribute their papers jointly. Most of the contributions are on Bibliometrics (36.45%). IT & Digital technologies in Libraries have also got sufficient papers. The institutional and geographical distribution of contributions is calculated. Most of the contributions are with citations. Majority of the library and information scientists have cited journals in large number (50.15%) while books comes on second with 273 (19.96%) citations. 'Annals of Library & Information Studies' occupies the 1st rank & 'Scientometrics' occupies the 2nd rank in the ranked list of cited journals.

Bakri, A. & Willett, P. (2008) carried out the citation patterns in the Malaysian Journal of Library and Information Science (MJLIS) from 2001-2006, the number of publications has increased from the 76 articles in the study to 85 articles here, with statistically significant changes in the types of article, in the numbers of references per article and in the lengths of the articles. The complete set of 161 articles attracted a total of 87 citations, 52 of which were self-citations, with 14% of the MJLIS articles having been cited at least once. Ambika, M; Alwarammal and Chinnadurai (2013), investigated that bibliometric analysis of the Annals of library and information studies journal for a period between 2002 and 2011. It was found that the year wise contribution of papers were maximum number 43 out of 283 during the year 2010.most of the articles were published from universities when the institution wise distribution of papers was analysed.

Baskaran C. (2013) observed that the bibliometric study on Cryptography published during 2000–2011 using the data retrieved from the Web of Science (WoS). A total number of 6610 records which were retrieved from the Web of Science was used to assess the academic productivity and distribution of research diversity of cryptography field from four major countries -China, USA, Taiwan and Japan which contributed more papers in cryptography and allied field of researches. The highest RGR is 0.44 in 2002 and Dt is 21. 656 in 2008 measured during the period. Pillai et.al. (2007), investigated the authorship pattern and collaborative research in physics with a sample of 11,412 journals and 1,328 book citations appended in the physics doctoral dissertations awarded by the Indian Institute of Science, during 1999-2003. The degree of collaboration in different years was calculated and the average value

of it for journals was 0.08 and 0.44 for books. The authorship collaboration is more in journal articles than in books. Mishra P.N., Goswami N.G and Panda K.C. (2013) evaluated the impact of 204 Grant-in-Aid projects at CSIR-National Metallurgical Laboratory, India during 1995–2010 through Bibliometric method. The trends of publications during 16 years showed that SCI papers were in increasing trends and reflect a healthy sign as performance indicators of the sponsored projects. The projects under basic research contributed a maximum of 226 papers with 845 citations, shared 64.50% of the total 1310 citations. The average impact factor of papers was 1.552. The highly cited papers published in the area of water quality-assessment, received 88 Citations, other highly cited papers fall in the domain of corrosion protection and prevention, waste management and utilization and materials science and technology.

Jena et.al. (2006), observed the trend of publications such as the year wise distribution of articles, bibliographical distribution of citations, authorship pattern, citation pattern, average length of articles, number of tables and figures used, time lag, geographical distribution of authors and subject analysis have been studied. Velmurugan, C. (2013), explored that from the study of the publication of papers in Annals of Library and Information Studies. The analysis conducted with 203 contributions published in the journal for a period of selected six years i.e. 2007 – 2012. It was observed from the study that the highest number of contributions i.e., 43 (21.19%) were published in the year 2010. Most of the contributions are found by double authored i.e., 88 (43.35 %.). The degree of collaboration (i.e.131out of 203) was high in terms of authorship pattern was 0.64. Serenko Alexander, Nick Bontis and Joshua Grant (2009), applied qualitative and quantitative data analysis techniques to determine author distribution, country, individual and institutional level productivity rankings, and employed methodologies. It was found that an average manuscript was written by 1.73 authors.

Objectives Of The Study

- To make an analyzes of articles published in IJBT from 2007 to 2012
- To observe the authorship pattern for a period of study
- To identify the year wise contributions of articles
- To study the period and volume wise authorship pattern
- To examine the author's productivity
- To scrutinize the single and multi-authored papers of the journal and
- To find out the Degree of collaboration

Methodology

The data have been collected from the NISCAIR website of Indian journal of Biotechnology. Four forty eight issues of six volumes from 2007 to 2012 have been selected six years for the study. For each article, year wise distribution of contributions, number of authorship, volume wise authorship, author's productivity and the single and multi-authored papers were noted down for the study. These data were organized, calculated, tabulated, analyzed and presented by using simple arithmetic and statistical methods for its results.

Results And Discussion

Distribution Of Contribution

Table no 1 shows that the year-wise distributions of articles have been arranged in which shows the highest number of contributions i.e., 87 (19.41 %) were published in the years 2007 whereas the minimum number of 64 (14.29 %) was published in the year 2010. From the above Table no 2 also reveals month and Issue-wise distribution articles in which Volume No. 6 shows the highest number of total articles. The second highest position is occupied by Volume No. 7. It is followed by volume 11and the lowest number of total articles in volume 9. The contribution of articles in volume 6 and 7 were more in October and December respectively.

Table. 1. Year / Volume / Month and Issue – wise Distribution of Articles

Month	Year / Volume No						Total No of Articles
	2007 / 6	2008 / 7	2009 / 8	2010 / 9	2011 /10	2012 / 11	
Jan – Mar	21	21	18	16	21	17	114
Apr – Jun	22	21	16	16	16	19	110
Jul – Sep	22	21	16	16	16	21	112
Oct – Dec	22	22	17	16	15	20	112
Total	**87**	**85**	**67**	**64**	**68**	**77**	**448**
%age	**19.41**	**18.97**	**14.96**	**14.29**	**15.18**	**17.19**	**100**

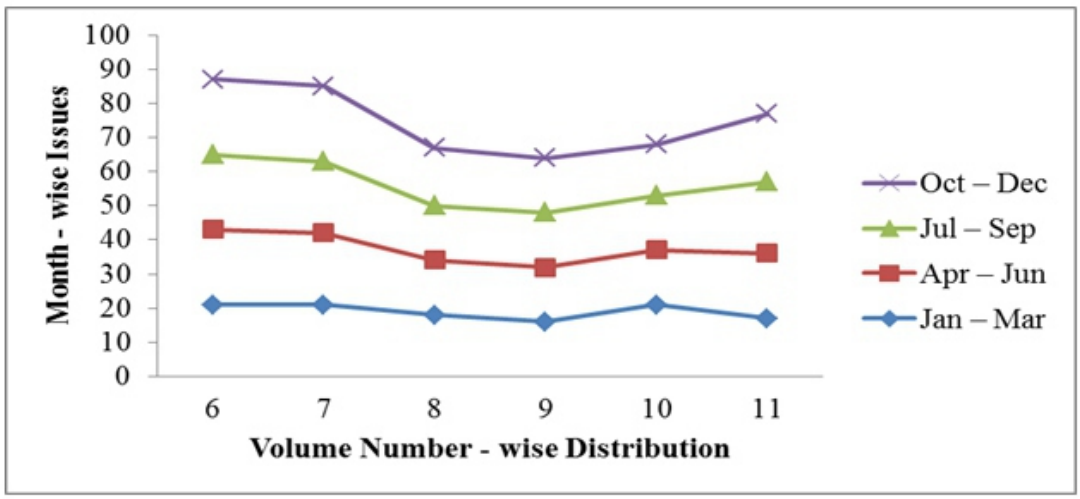


Table. 2. Distribution of Document Type Papers

Document Type	Total No of Papers	Total No of Selected papers	%age
Review	48	48	10.71
Articles	331	331	73.88
View points	2	-	-
Short communications	69	69	15.41
Conference Reports	1	-	
Book review and others	3	-	-
Total	**454**	**448**	**100**

Table 2 shows that this study aims to explore papers with references, such as articles, reviews, short communications, and news and conference reports, 448 articles were only selected for further exploration. It indicates that the majority 73.88 % of papers and followed by 15.14 % of short communications were noted down for the period of study.

Authorship Pattern

Table 3. Authorship Pattern

Kinds of Authors	Total No of contributions	% of Records
Single Author	12	2.67
Double Authors	106	23.66
Three Authors	120	26.79
Four Authors	105	23.44
Five Authors	61	13.62
More than five	44	9.82
Total	**448**	**100**

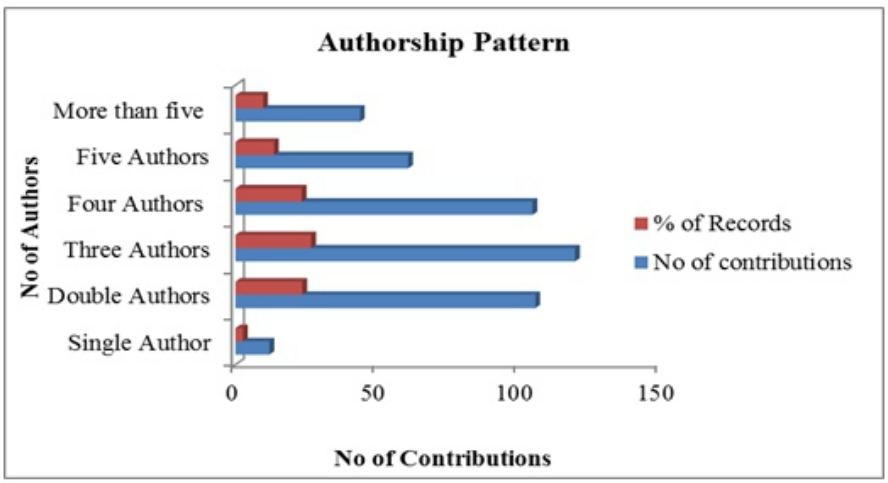


Fig. 2. Authorship Pattern

The table.3 reveals that the details about the authorship pattern of articles published during the period of study. Out of total of 453 articles, the maximum number of contributions i.e. 124 (27.38 %) have been contributed by Three authors and followed by 117 contributions (25.83 %) and 99 contributions (21.85 %) and the minimum number of contributions i.e. 12 (2.64 %) by single author.

Table. 4. Year - wise Authorship Pattern

Authors	Year						Total	% of Records
	2007	2008	2009	2010	2011	2012		
Single Author	3	19	21	14	6	9	72	16.07
Two Authors	2	15	16	18	12	10	73	16.29
Three Authors	2	11	15	20	13	7	68	15.18
Four Authors	2	12	23	16	10	3	66	14.74
Five Authors	1	29	24	14	10	6	84	18.75
More than Five	2	20	21	23	10	9	85	18.97
Total	**12**	**106**	**120**	**105**	**61**	**44**	**448**	**100**
Percentage (%)	**2.67**	**23.66**	**26.79**	**23.44**	**13.62**	**9.82**	**100**	

The table shows volume wise authorship pattern of contributions. It indicates that out of the 72 contributions of single author, volumes 8 has the highest number i.e., 21 (29.17 %) whereas the volume 6 has the lowest number i.e. 3 (4.17 %) contributions. Out of the 73 contributions by two authors, vol. 9 has the highest i.e. 18 (24.65 %) and vol. 6 has the lowest number i.e., 2 (2.73 %) contributions. Out of 68 contributions by three authors, vol. 9 has the highest i.e. 20 (29.41 %) and vol. 6 has the lowest number i.e., 2 (2.94 %) contributions. Out of 66 contributions by four authors, vol. 8 has the highest number i.e. 23 (34.84 %) and the vol. 6 has the lowest number i.e. 2 (3.03 %) contributions. Out of 84 contributions by five authors, vol.7 has the highest number i.e. 29 (34.52 %) and vol.6 has the lowest number ie 1 (1.19 %) contributions. Out of 85 contributions done by more than five authors' volumes 9 has the highest i.e. 23 (27.07 %) and vol.6 has the lowest number i.e. 2 (2.35 %) of lowest authors.

Table. 5. Authorship pattern of single and joint contributions

Years	2007	2008	2009	2010	2011	2012	No of Articles	% of Records
Single	3	2	2	2	1	2	12	2.67
Joint	69	71	66	64	83	83	436	97.33
Total	**72**	**73**	**68**	**66**	**84**	**85**	**448**	**100**

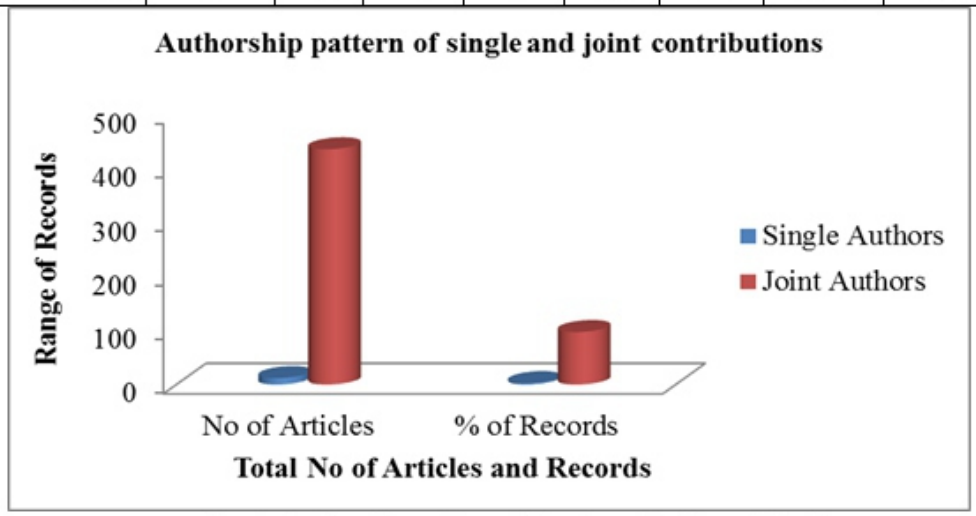


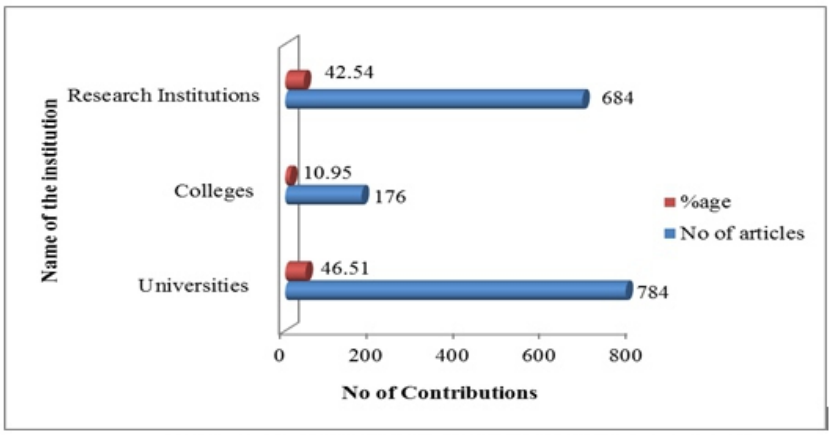
Fig. 3. Authorship pattern of single and joint contributions

Table no 5 indicates that out of 448 articles single author contributed only 12 (2.67 %) articles while the rest 436 (97.33 %) articles were contributed by joint authors. It showed that the majority of the articles have been contributed only by multiple authors.

Institution Wise Distribution

Table. 6. Institutions – wise Distribution of Contributions

Institutions	No of articles	%age
Universities	784	46.51
Colleges	176	10.95
Research Institutions	684	42.54
Total	**1608**	**100**



Graph. 3. Institutions – wise Distribution of Contributions

Table 6 shows the type of institutions with which the authors of the articles were affiliated. Out of 448 contributions, the highest number of i.e. 784 articles (46.51 %) were from authors affiliated with Universities and followed by 684 articles (42.54 %) were from Research Institutions and the lowest number i.e. 176 (10.95 %) has been contributed by Colleges.

Geographical Distribution Of Articles

Table. 7. Geographical Distribution of Articles

Name of the institution	No of articles	%age
Indian	411	91.74
Foreign	37	8.26
Total	**448**	**100**

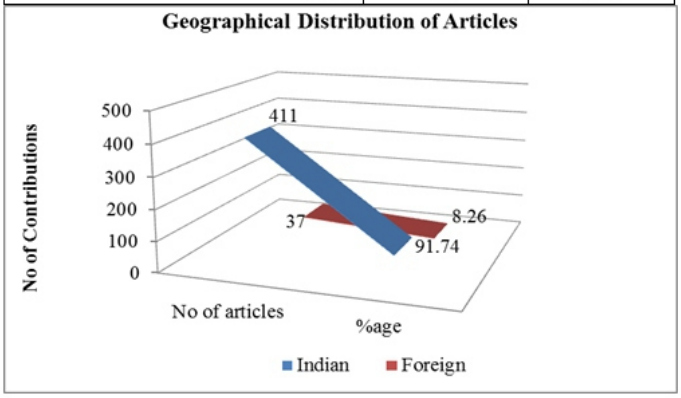


Fig. 4. Geographical Distribution of Articles

The table 7 showed that most of the contributions are from India with 91.74 % and the rest 8.26 % only from foreign sources.

Degree Of Collaboration

Table 8. Degree of Collaboration

Year	Volume	No of Authors		Total	Degree of Collaboration
		Single	Multiple		
2007	6	3	69	72	0.95
2008	7	2	71	73	0.97
2009	8	2	66	68	0.97
2010	9	2	64	66	0.96
2011	10	1	83	84	0.98
2012	11	2	83	85	0.97
	Total	**12**	**436**	**448**	**0.97**
Percentage %		**2.67**	**97.33**	**100.00**	

Table - 8. The degree of collaboration ranges from 0.95 to 0.98 and the average degree of collaboration is 0.97. The degree of collaboration is calculated by using the following formula (K. Subramanyam, 1982):

The formula is Where C= Degree of Collaboration Nm = Number of multiple authors Ns = Number of single authors	**C =**	$C = \frac{N_m}{N_m + N_s}$
	C =	$\frac{436}{436 + 12 = 448}$
In the present study the value of **C** is	**C =**	**0.97**

As a result, it was found that the degree of collaboration in the journal Indian Journal of Biotechnology is 0.97.

Page Distribution

Table 09 reveals the average papers per volumes per contribution.

Average pages per volumes = 3095/6 = 515.8

Average pages per issues = 3095/24 = 12. 89

Average pages per contribution =3095/448 = 6.90

Table 9 : Average Pages : Per Volume

Year	Vol. No	Total pages	No of contributions	Average
2007	6	526	87	6.04
2008	7	507	85	5.96
2009	8	419	67	6.25
2010	9	399	64	6.23
2011	10	464	68	6.82
2012	11	458	77	5.94
	Total	**3095**	**448**	**100**

Table no 9 indicates that 448 articles published with a total page of 3095 (average 6.90 pages per article) during the year 2007 -2012. It is observed that the average length of the articles varied from a minimum of 5.94 pages in the year 2012 to a maximum of 6.82 pages in the year 2011.

Table 10: Distributions of Pages (Volume-wise) & No. of Pages in Each Issue

Month	Year / Volume					
	2007 / 6	2008 / 7	2009 / 8	2010 / 9	2011 / 10	2012 / 11
January	119 (9-127)	132 (9-140)	127 (9-135)	99 (7-105)	141 (9-149)	107 (7-113)
April	142 (141-282)	114 (159-272)	99 (147-243)	108 (119-224)	87 (161-247)	112 (129-240)
July	130 (293-422)	127 (283-409)	86 (253-338)	105 (233-337)	115 (257-371)	106 (251-356)
October	135 (435-569)	134 (423-556)	109 (349-457)	87 (351-437)	121 (387-507)	133 (369-501)
Total	**526**	**507**	**419**	**399**	**464**	**458**
%age	**16.99**	**16.38**	**13.53**	**12.89**	**14.99**	**14.79**

From the data, the above table no 10 shows that the distributions of pages in Volumes wise and no. of pages in each issue.

Table 11: Total No of Visitors: (Online Journal)

Month	Year and Volume wise Issues					
	2007 / 6	2008 / 7	2009 / 8	2010 / 9	2011 / 10	2012 /12
Jan - Mar	1929	2467	3769	5543	4318	5028
April - Jun	1775	2196	2918	3026	2315	2237
July - Sep	1648	2012	2934	2770	2152	2289
Oct - Dec	1683	1928	2640	2306	2006	1628
Total	**7035**	**8603**	**12261**	**13645**	**10791**	**11182**
%age	**11.07**	**13.54**	**19.30**	**21.48**	**16.98**	**17.60**

Table: 11, the data was noted down from the official website of http://nopr.niscair.res.in/ on 24th in the month of September 2013. A total number of 63517 online visitors from 2007 to 2012 in which the highest number of 13645 visitors has 21.48 % in the year 2010 and the lowest number of 7035 visitors has 11.07% in the year 2007.

Findings & Conclusion

The analysis investigated and revealed the following major findings and conclusions.

- The highest number of contributions i.e., 87 (19.41 %) were published in the years 2007.
- The highest number 436 (97.33 %) articles were contributed by joint authors and the rest of 12 (2.67 %) articles contributed by single author.
- Out of 448 contributions, the highest numbers of i.e. 784 articles (46.51 %) were from authors affiliated with Universities.
- The most of the contributions are from India with 91.74 % and the rest 8.26 % only from foreign sources.
- The degree of collaboration in the journal Indian Journal of Biotechnology is 0.97.
- The average length of the articles varied from a minimum of 5.94 pages in the year 2012.
- The highest number of 13645 visitors watched the website has 21.48 % during the year 2010.

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A Biochemical Study On Antioxidant Enzymes In Citrus Fruits Peel

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ABSTRACT

Three species of citrus fruits were chosen to investigate and evaluate levels of enzymatic antioxidants in peels of C.reticulata, C.sinensis and C. aurentifolia. The results indicate that amongst these 3 citrus fruits peels; the specific activity (U mg-1protein) of enzymatic antioxidants viz., ascorbic acid oxidase, guaiacol peroxidase, glutathione reductase, polyphenol oxidase and superoxide dismutase were highest in peels of C.aurentifolia (201 ± 18.05, 4.82 ± 1.62, 0.369 ± 0.03, 9538.4 ± 8.32 and 28.56 ± 2.90 respectively) with the exception of catalase which was highest in peels of C.sinensis (1310 ± 9.56 U mg-1protein). The results obtained suggest metabolism of enzymatic antioxidants is more or less similar in citrus fruits peel indicate a potential for cheap and readily available natural source of antioxidants with health protective potential, which can be used in pharmaceutical, nutraceutical and food preparations.

Key words: Enzymatic antioxidants, Citrus peels, glutathione reductase, polyphenol oxidase, superoxide dismutase.

Citrus fruits have long been valued as part of a nutritious and tasty diet. The flavours provided by citrus are among the most preferred in the world and it is increasingly evident that citrus not only tastes good, but is also good for people. It is well established that citrus and citrus products are a rich source of vitamins, minerals and dietary fiber (non-starch polysaccharides) that are essential for normal growth and development and overall nutritional well-being. Manthley and Grohmann (2001) and Anagnostopoulou et al., (2006) citrus fruits are the world's most popular fruits. Citrus plants originated in south-east Asia and spread gradually to other parts of the world. The two most important orange growing / processing regions are Brazil and Florida in the US. The genus citrus belonging to the family Rutaceae comprises about 40 species which are distributed in India, China, Malaysia and Australia. Natural foods, especially citrus products, play a major role in human nutrition as excellent sources of antioxidants, including ascorbic acid, carotenoids, flavonoids and phenolics compounds. Citrus fruits contain biologically active compounds (or substances) which possess antioxidant activity. They are essential components of functional food as they help to prevent unwanted damage to cell membranes and other structures of the body by neutralizing free radicals. Antioxidants in citrus fruits possess

antitumor activity. The peel which represents almost one half of the fruit mass contains the highest concentrations of flavonoids in the Citrus fruit. Okwu et al., (2006) reported that ascorbic acid – vitamin C – is the most important nutrient in citrus fruits, is essential for the synthesis of collagen, the most abundant protein in mammals. Collagen is the major fibrous element of skin, bone, blood vessels and teeth. A lack of vitamin C leads to scurvy which causes the loss of teeth, skin bleeding and ulcers. Vitamin C is sometimes suggested to have an anticancer effect because of its inactivation of free radicals in the body. Vitamin C is the most important antioxidant in citrus fruit, which protect the organism from oxidative stress. Halliwell (2007) stated that exposure of biological systems to xenobiotics pollutants, ionizing radiation or U.V. light and development of certain pathological conditions lead to oxidative stress, consequently increase production of oxy radicals. All are capable of reacting with membrane lipids, nucleic acids, proteins, enzymes and other small molecules, resulting in cellular damage which is caused by free radicals appears to be a major contributor in aging and degenerative diseases of aging such as cancer, cardiovascular disease, cataracts, compromised immune system, rheumatoid arthritis and brain dysfunction. Antioxidant action includes free radical scavenging, inhibition of lipid peroxidation, metal ion chelating ability and reducing capacity. The objective of the study was to assay and compare the levels of antioxidant enzymes in peels of C.sinensis, C.reticulata and C. aurentifolia.

Materials And Methods

Chemicals and reagents

All chemicals and reagents were analytical grade and general purpose reagents unless otherwise stated.

Procurement of samples

The following fresh citrus fruits a) C.sinensis (sweet lime) b) C.reticulata (orange) and c) C.aurentifolia (common lime) were purchased from local market of Allahabad, U.P., India.

Preparation of enzyme extracts

The fruit peels were washed thoroughly with tap water and rinsed with distilled water. A 10% homogenate (w/v) was prepared in the pre-chilled extraction buffer prescribed for each enzyme (usually the buffer used for assay of the enzyme) using mortar and pestle and filtered. The residue was discarded and supernatant used immediately for enzyme assay. The entire process was carried out at a temperature close to 4^0C.

Ascorbic acid oxidase (EC.1.10.3.3)

The ascorbic acid oxidase activity measured was based disappearance of substrate (L-ascorbic acid) according to Oberbacher and Vines (1963) method. The reaction mixture contained 3 ml of substrate solution(ascorbic acid in phosphate buffer of PH 5.6) and 0.1 ml of enzyme extract (homogenised in phosphate buffer of pH 6.5). The change in absorbance was measured at 265 nm in 1min interval for 5min.calculn

Catalase (EC.1.11.1.6)

Catalase activity was monitored by following the disappearance of H_2O_2, its substrate from the assay mixture, using the method of Manonmani et al. (2009). The standard reaction mixture (3.0 ml) contained phosphate buffer (46.7mM, pH 7.0) and H_2O_2(15mM). The enzyme extract (100µl) was added to initiate the reaction. A control was prepared by adding buffer instead of enzyme extract. Tubes were shaken and the decrease in H_2O_2 concentration was measured as the decline in A240 during the first 10min after initiation of the reaction. Enzyme activity was expressed as changes in absorbance (Units ml-1).

Guaiacol Peroxidase (EC.1.11.1.7)

The activity of peroxidase was assayed by measuring the oxidation of guaiacol to form tetraguaiacol in the presence of H_2O_2 according to the method given by Chanda and Singh (1997). The reaction mixture contained 1ml each of the 8mM potassium phosphate buffer (pH 6.5), 1mM H_2O_2, 4mM guaiacol and enzyme extract. The change in absorbance at 470 nm due to the oxidation of guaiacol to form tetraguaiacol in the presence of H_2O_2 was measured.

Glutathione reductase (EC.1.6.4.2)

Glutathione reductase activity was done according to the method given by smith et al., (1988). This assay was based on the increase in absorbance at 412 nm when 5,5-dithiobis (2-nitrobenzoic acid) (DTNB) is reduced by GSH. The reaction mixture contained 1.0 ml 0.2 M potassium phosphate (pH 7.5) containing 1 mM EDTA, 0.5 ml 3 mM DTNB in 0.01 M phosphate buffer, 0.25 ml H_20, 0.1 ml 2 mM NADPH, 0.05 ml glutathione reductase (1 U/ml), and 0.1 ml 20 mM GSSG. Glutathione reductase (extract) was kept in an ice-bath during preparation of the mixture, but its temperature equilibrated rapidly when it was added to the other components kept at room temperature. The reaction initiated by the addition of GSSG. The temperature was maintained at 24°C. The increase in absorbance at 412 nm was monitored using a spectrophotometer.

Polyphenol oxidase (EC.1.14.18.1)

The polyphenol oxidase (PPO) activity was measured by the increase in absorbance at 420nm with the oxidation of catechol as substrate according to the method given by Liu et al., (2005). The reaction mixture contained 1.0 ml of 0.1M catechol, 1.9 ml 0.1M phosphate buffer (pH 7.0), 0.1 ml of enzyme extract and incubated for 10 min at 30 ^{0}C . The increase in absorbance was measured at 420 nm with a spectrophotometer. One unit of PPO activity was expressed as $0.001\Delta A_{420}$ min $^{-1}$g $^{-1}$ fresh weight.

Superoxide dismutase (EC.1.15.1.1)

The activity of superoxide dismutase was assayed by measuring its ability to inhibit the photochemical reduction of nitroblue tetrazolium (NBT) according to the method given by Calatayud et al., (2002). The reaction mixture contained 1ml each of 50mM potassium phosphate buffer (pH 7.8), 10mM methionine, 57µM nitroblue tetrazolium (NBT), 1.0µM riboflavin, 0.025 % (v/v) Tween-20 and enzyme extract. Then was thoroughly mixed and kept under fluorescent light of 30W for 15min placed 20cm away. Absorbance was recorded at 560 nm after the illumination period. In this assay, 1 unit of SOD was defined as the amount of enzyme necessary to produce a 50 % inhibition of the NBT photo reduction.

Results And Discussion

Activity of Ascorbic acid oxidase in citrus peels

Activity of ascorbic acid oxidase in C.aurentifolia peels was to be maximum (201.0U/mg protein) whereas C.sinensis peels exhibited minimum activity (81.6 U/mg protein) according to Table 1. Since, literature on ascorbic acid oxidase activity in citrus fruits/peels is not readily available therefore; similar literature is quoted on various vegetables. Shimada et al., (2008) reported activity of ascorbic acid oxidase (units/100g) in broccoli (11.88), pumpkin (8.45), spinach (7.30), tingentsai (5.12), cabbage (4.96), carrot (4.22), taatsai (3.42), stalk garlic (3.27) and raddish (0.14).

Activity of catalase in citrus peels

Peels of C.sinensis had maximum specific activity (1310.0 units/mg protein) whereas C.reticulata peels had minimum activity (820.4 units/mg protein) according to Table 2. Since, literature on catalase activity in citrus peels is not readily available therefore; similar literature on other plant samples is being quoted. Yoruk et al., (2005) reported a specific activity of catalase (29.43 U/mg proteins) in Van Apple fruit. Manonmani et al., (2009) reported 0.418 Units/min/g fresh tissue of catalase activity in healthy leaves of lime.

Activity of guaiacol peroxidase in citrus peels

The data presented in Table 3 shows that C.aurentifolia peels exhibited maximum specific activity (4.82 units/mg protein) and C.reticulata had the least activity (2.98 units/mg protein). Zia et al., (2011) reported similar literature on guaiacol peroxidase in seeds of orange with 0.59U/mg activity.

Activity of glutathione reductase in citrus peels

The data presented in Table 4 shows that C.aurentifolia peels exhibited maximum specific activity (0.369 units/mg protein) and C.sinensis had the least activity (0.031 units/mg protein). Smith et al., (1988) reported similar literature on crude extracts of soybean. From the above result it is concluded that C.aurentifolia peels possess high enzymatic antioxidants activity with the exception of catalase activity which is highest in C.sinensis peels. Iannelli et al., (2002) reported glutathione reductase activity (nkat per mg protein) of Phragmites australis leaves, roots and stolons 1.5 ± 0.3, 6.8 ± 0.8 and 4.3 ± 0.8 respectively.

Activity of polyphenol oxidase in citrus peels

Peels of C.aurentifolia exhibited maximum specific activity (9538.4 units/mg protein) and C.reticulata had the least activity (4154.9 units/mg protein) according to Table 5.Wang et al., (2006) reported similar literature on mango pulp (100 ± 8.8 % activity) with catechol as a substrate.

Activity of superoxide dismutase in citrus peels

The data presented in Table 6 shows that C.aurentifolia peels exhibited maximum specific activity (28.56 units/mg protein) and C.sinensis had the least activity (7.60 units/mg protein). Iannelli et al., (2002) reported superoxide dismutase activity (U/mg protein) of Phragmites australis leaves, roots and stolons 12.5 ± 1.8, 35.9 ± 1.6 and 37.0 ± 1.0 respectively. Rani et al., (2004) observed 13.24 unit/mg protein of superoxide dismutase in orange fruit. The slight difference in results of C. reticulata (9.86 units/mg protein) maybe due to different assay method adapted and also due to peels which were used as a sample.

Table 1: Activity of ascorbic acid oxidase in citrus peels:

Citrus species	Enzymatic activity(mg of ascorbic acid oxidized/ml)	Specific activity (activity/mg protein)
C. reticulata	31.24 ± 0.02	110.0 ± 11.2
C.aurentifolia	26.13 ± 0.03	201.0 ± 18.05
C.sinensis	21.06 ± 0.12	81.6 ± 5.78

The values are MEAN ± S.D. (n = 3).

Table 2: Activity of catalase in citrus peels:

Citrus species	Enzymatic activity*	Specific activity (activity/mg protein)
C. reticulata	233± 0.78	820.4 ± 8.64
C.aurentifolia	128 ± 0.05	984.6 ± 7.01
C.sinensis	338 ± 1.20	1310.0 ± 9.56

The values are MEAN ± S.D. (n = 3).
*One unit of enzyme activity is defined as that amount of enzyme which breaks down 1µmole of H_2O_2 under the assay condition.

Table 3: Activity of guaiacol peroxidase in citrus peels:

Citrus species	Enzymatic activity*	Specific activity (activity/mg protein)
C. reticulata	0.8470 ± 2.1	2.98 ± 0.12
C.aurentifolia	0.6268 ± 1.71	4.82 ± 1.62
C.sinensis	0.8734 ± 2.31	3.38 ± 1.02

The values are MEAN ± S.D. (n = 3).
*U/mL
* The peroxidase activity was expressed as the rate of change of optical density (O.D.) per minute.

Table 4: Activity of glutathione reductase in citrus peels:

Citrus species	Enzymatic activity*	Specific activity (activity/mg protein)
C. reticulata	0.085 ± 0.31	0.299 ± 0.02
C.aurentifolia	0.048 ± 0.02	0.369 ± 0.03
C.sinensis	0.008 ± 0.42	0.031 ± 0.001

The values are MEAN ± S.D. (n = 3).

* U/mL
* One unit will cause the reduction of 1.0 mmole of DTNB to TNB at 25°C at pH 7.5.

Table 5: Activity of polyphenol oxidase in citrus peels:

Citrus species	Enzymatic activity*	Specific activity (activity/mg protein)
C. reticulata	1180 ± 2.51	4154.9 ± 3.76
C.aurentifolia	1240 ± 2.83	9538.4 ± 8.32
C.sinensis	1160 ± 1.98	4496.1 ± 3.54

The values are MEAN ± S.D. (n = 3).
* ΔA_{420}/min/g fresh wt.

Table 6: Activity of Superoxide dismutase in citrus peels:

Citrus species	Enzymatic activity*	Specific activity (activity/mg protein)
C. reticulata	2.802 ± 1.02	9.86 ± 2.08
C.aurentifolia	3.714 ± 2.04	28.56 ± 2.90
C.sinensis	1.962 ± 0.35	7.60 ± 1.02

The values are MEAN ± S.D. (n = 3).

* One unit of 1 unit of SOD is defined as the amount of enzyme necessary to produce a 50 % inhibition of the NBT photoreduction.

It is widely accepted that consumption of fruits and vegetables is beneficial to health and contributes to decrease of the mortality rate of cardiovascular and other diseases. This study conducted for the assays of enzymatic antioxidants, ascorbic acid oxidase, catalase, guaiacol peroxidase, glutathione reductase and superoxide dismutase. The specific activity (units/mg protein) of enzymatic antioxidants viz. superoxide dismutase (28.56), guaiacol peroxidase (4.82), ascorbic acid oxidase (201), polyphenol oxidase (9538.4) and glutathione reductase (0.369) were highest in peels of C.aurentifolia with the exception of catalase which was maximum in peels of C.sinensis. The results obtained suggest metabolism of enzymatic antioxidants is more or less similar in citrus fruits peel whereas production of non-enzymatic antioxidants varies, indicates a potential for cheap and readily available natural source of antioxidants with health protective potential, which can be used in pharmaceutical, nutraceutical and food preparations. However, further studies required before these can be used as a source of antioxidants.

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Role of "Root to Stem" Cooking Concept in Food Sustainability

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ABSTRACT

Background: A sustainable food system is a collaborative network that integrates several components in order to enhance a community's environmental, economic and social well-being. "Root to Stem" cooking concept is an art of using all the parts of vegetables and fruits in the food preparation. This cooking concept not only increases the yield of fruits and vegetable but the dishes prepared are more nutritive and flavourful. Objective: To increase the yield of vegetables and fruits used in the preparation of various dishes. Methods: Implementation of "Root to Stem" cooking concept was done in the food production lab which undertakes bulk cooking & caters to the students during lunch. The data on usage of quantity of vegetables & fruits was accumulated from the store department which issues the vegetables and fruits to all the production labs. Data on usage of vegetables and fruits before implementing the root to stem cooking concept and after implementing the root to stem cooking concept was compared and analysed. Results: With introduction of "Root to Stem" cooking concept there was 33% decrease in the cost of vegetables and fruits purchased for quantity food lab. Conclusion: The hotel industry and other institutions which caters food services to a large amount of people can also look into the idea of implementing the "Root to Stem" concept in their food and beverage outlets. The root to stem cooking concept not only helps financially and increase the nutritional aspect of food but also reduces the problem of land fill which is a major issue worldwide. This concept can help in achieving food sustainability and thereby it helps in achieving communities environmental, economic and social well being.

Key Words: Food Sustainability; Root to Stem Cooking Concept; Yield Management

1. Introduction

Increasing the yield of food raw material especially fruits and vegetable is very important as underutilizing the raw material is going to lead towards food waste. Food waste is a big issue which needs to be tackled by the hospitality industry. The impact of food waste is not just financial. It has an enormous impact on the environment; it affects the overall atmosphere of the world. Environmentally, food waste leads to wasteful use of chemicals such as fertilizers and pesticides; more fuel used for transportation; and more rotting food, creating more methane – one of the most harmful greenhouse gases that contributes to climate change. Not only the end product but also underutilised food material is also part of the landfill. According to Shindell et al (2009), Methane has a global warming potential 86 times that of CO_2 on a 20 year time frame. The vast amount of food going to landfills makes a significant contribution to global warming.

According to Jacquot (2008) huge amounts of food close to half of all food produced worldwide are wasted after production. The U.N. Food and Agriculture Organization (FAO) (2011) estimated that 1.3 billion tonnes of food are wasted annually. According to Christian (2013), the total amount of food wasted in the U.S. exceeds that of the United Kingdom, Italy, Sweden, France, and Germany combined. In addition, the U.N. Environment Programme (UNEP) (2010) estimated that global food production accounts for 70 percent of fresh water use and 80 percent of deforestation. As per Pal (2015), food production is also the largest single driver of biodiversity loss and creates at least 30 percent of global greenhouse gas emissions. As per The Culinary Exchange (2015), one-third of the world's food supply is wasted, this adds up to around 1.6 billion tonnes of food worldwide on an annual basis. It has been seen that when thrown away, around 1.3 billion tonnes is still edible.

According to The Culinary Exchange (2015), the equivalent price of the world's annual food waste comes out to around 1 billion dollars. According to United Nations Water Organization (2013), irrigation now claims close to 70 percent of all freshwater appropriated for human use. This water also gets wasted if the food is wasted.

According to a report published by The Culinary Exchange, (2015) 28% of the world's agricultural land is used to produce food that will be wasted or lost. Also, composting at home could save 330 pounds of food waste per household each year from going into landfills compared to 20 pounds of food waste per person per month in the U.S.

According to the United Nations Development Programme (2015), up to 40% of the food produced in India is wasted. About 21 million tonnes of wheat are wasted in India and 50% of all food across the world meets the same fate and never reaches the needy. In fact, according to the agriculture ministry, Rs. 50,000 crore worth of food produced is wasted every year in the country. India ranks 55 in Global Hunger Index (2015) as per The Economic Times. According to a survey by Bhook (An organization working towards reducing hunger) 2013, reported that 20 crore Indians sleep hungry on any given night. In 2013, Honourable Minister of Food Processing Industry, Mr. Sharad Pawar informed that the value of annual wastage of fruits and vegetables was estimated at Rs 13,309 crore. However, if the wastage value of rice, wheat, cereals and others are taken into account, it would go up to Rs 44,000 crore a year. Due to lack of adequate storage infrastructure, fruits, grains and vegetables worth Rs 44,000 crore go waste every year. According to Sharma (2012), food wastage in India is less than 40%, i.e., 5.8 to 18% in fruits; 6.8 to 12.4% in vegetables and 4.3 to 6.1% in cereals.

As per Gunders (2012), 40% of all landfill content comes from food waste in US. According to Environment Protection Agency (2016), food waste is the second largest category of municipal solid waste (MSW) sent to landfills in the United States, accounting for approximately 18% of the waste stream. That is over 30 million tons of food waste that the U. S. sends to the landfills each year. Of the less than 3% of waste currently being diverted from landfills, most of it is being composted to produce a fertilizer.

The David Foundation (2014) reported that about 20% of Canada's methane emissions (a greenhouse gas that traps more heat in the atmosphere than carbon dioxide) come from landfills. Gooch et al (2010) suggests that more than half (50 per cent) of the estimated $27 billion of food wasted countrywide ends up as unwanted leftovers dropped into household trash bins. VCMC report also came out with the fact that 8% of food is wasted in Canada

Food Waste Reduction Alliance found that approximately 80 billion pounds of food are discarded into landfills in the United States every year; restaurants account for 37 percent of the waste that hits landfills. Additionally, rotting food in open landfills releases large quantities of methane, a greenhouse gas with 20 times more warming potential than carbon dioxide (Fischer 2015).

As per guide Managing Food Waste in the Hospitality and Food Service Industry published by Resource Efficient Scotland (2014) the following steps may be taken to reduce food waste in the Hospitality Industry: Purchasing, ordering and menu design, thinking carefully about menu design is one of the key ways to reduce waste and help realise cost savings, storage, handling produce properly is the first step to ensure that product shelf life is maximised as bruised or damaged fresh products will result in extra waste. Check produce on delivery and return anything that is damaged, storing fresh products and raw ingredients in the most appropriate environment will increase their usable life, continually rotate produce by putting the newest product at the back of the shelf so that the oldest automatically gets used first, clearly label products with their purchase and best before dates, to help with accurate ordering try to place all the items of the same type (e.g. cans) from the same supplier on one shelf or in one area. This way one can easily see what you need, try to work towards 'just-in-time' delivery rather than pre-ordering in quantity. This will help to minimize storage costs and spoilage.

At Taste Restaurant at the Seattle Art Museum, tiny carrots were blended into soup. Small onions were roasted whole. Lumpy potatoes and oversize leeks bolstered a creamy turnip soup that was already on the menu. Imperfectly Delicious produce accounts for about 10% of that restaurant's fruits and vegetables.

With this it becomes a prime responsibility of all human beings especially who are involved in hospitality sector to come together to increase the yield of food and work towards sustainability of food. Such initiatives can help reduce green house gases, reduce economic and indirect losses and hunger of million people. Keeping in mind the issues the objective of the current study objective was:

- To increase the yield of vegetables and fruits used in the preparation of various dishes

Methodology

The present work is a quantitative design wherein an attempt was made to increase the yield of vegetables and fruits being used in the preparation of various dishes. For this purpose the study was conducted in Institute of Hotel Management, Pusa, New Delhi as it is the hospitality institute featuring culinary sciences. There are in total 10 food production labs in the institute namely Advance Training Kitchen (ATK), Quantity Food Kitchen (QFK), Basic Training Kitchen (BTK), CCK (Craft Course Kitchen), Craft Course Food Production (CCFP), three Bakery labs, a Confectionary Lab and a Mess Kitchen. To study the yield of fruits and vegetables at the time of processing and there use in preparation of various dishes Quantity Food Kitchen (QFK) was selected as a sample kitchen. In QFK, the students are trained to handle bulk cooking and it caters to the students (n=750) of the institute during lunch on all working days. Root to stem cooking concept was implemented in the QFK from February to March 2106. The data on purchase of the fruits and vegetables was collected from the store department which handles the accounts of food items.

Results And Findings

The concept of "Root to Stem" of cooking was introduced in QFK. This resulted in drastic reduction of waste being generated from QFK from 20 kgs to 2.5 kgs. The success of implementation of this concept was seen from the reduction in purchase cost of vegetables and fruits from last 3 years (March 2013, March 2014 and March 2015) to this year for the month of March 2016, which was 34% (Table 1). These figures suggested that minimum scrap was generated in QFK and the vegetables and fruits were utilized to its maximum for feeding staff and students.

Table 1: Comparison of Costing for Vegetables (March 2013-2015 vs March 2016)

Period	Cost
Average cost of purchase of Vegetables and Fruits for the Month of March (2013-2015)	Rs. 1,33,127/-
Cost of purchase of Vegetables and Fruits for the month of March 2016	Rs.88,315/-
Reduction in Cost	**34%**

Fruits and vegetables account for the largest category of wasted food, according to Gunders (2012). This surpasses seafood, grain products, meat, and dairy products.

According to a study from Harvard Law School and the Natural Resources Defense Council, 22 percent of food waste comes from fruit and vegetables. Of the fruit and vegetables bought, 52 percent of them are discarded and only 48 percent is consumed. Thus, concepts like Root To Stem can be utilized by hospitality sector, kitchens and hospitality educational institutes to minimize on food waste.

Weinberg (2007), suggested that don't over-peel fruits and vegetables, cheaper cuts of meat for stews and soups should be fully utilized, and utilize all parts of fish, meat, or vegetables in stocks, purees, and dips. Food should be used to maximum to minimise its wastage.

Offer "skin-on" boiled, baked and roasted potatoes to reduce the amount of peelings you throw away. Try to avoid pre-preparation of food which will spoil quickly, and store leftover food safely for use the next day where appropriate. Get creative with trimmings and excess to make pâtés, soups and stocks. Freeze excess berries for coulis or smoothies, and excess bread can be made into bread crumbs or croutons.

Controlling portion size is another way to reduce waste. “Portion control in a buffet operation is an art. Careful calculations are necessary to prevent over production” (Dunbar, 2006). Dyson, Food & Technical Affairs Adviser, British Hospitality Association 2014 said, “Better inventory management (e.g. Use of FIFO racks) reduces the waste of date-expired meals.”

Conclusion

The study conducted in the institute helped in increasing the yield of fruits and vegetable at the time of processing. The study focused that if the fruits and vegetables are not underutilized, it helps in optimal utilization of resources by increasing yield of ingredients, overall reduction of cost and also the problem of disposing waste. Hospitality industry wastes a large amount of edible food on a daily basis as they lay high emphasis on eye appeal of food. The industry can also look into the idea of re-designing its menu and also innovative concept of “Root to Stem” cooking to cut down on the amount of food being thrown in the drain. Such initiatives should be taken further by the monitoring bodies so that it can be implemented in other hospitality education institutes and together all can work for the sustainable environment.

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Role Of Combo Meals In Food Sustainability

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ABSTRACT

BACKGROUND: Sustainability is an emerging trend which is vitally important for organisation's growth and should be implemented in everyday practices especially in kitchens as food plays very important role day in and day out in life cycle of human beings. Hospitality Industry needs to implement such practices in order to enhance social and economic development of the country. Combo meal is one of the upcoming options in improving the food sustainability issues in our country. The study will outshine the benefits of choosing combo meals especially in terms of nutrition, financial and social responsibility. OBJECTIVES: To develop combo meals for restaurant service, to perform Sensory Evaluation of the products developed and to analyse the cost effectiveness of combo meals. METHODOLOGY: Observing the North Indian palette, five different combo meals will be planned. The planned combo meals will undergo sensory evaluation. The cost analysis will be done between combo meals and thali meals. RESULTS: Five different North Indian combo meals will be developed. Sensory Evaluation will be performed by the faculty and office staff of IHM Pusa. For cost analysis full thali meals will be compared to combo meals. CONCLUSION: Combo meals will be one of the right choices in order to improve Food Sustainability issues of our ever growing country.

KEY WORDS: Sustainability, Combo Meals, Sensory Evaluation, Full Meal Platter.

1. Introduction

Over the years Sustainability has been defined in many different ways, but has often set its focus on environmental concerns (Sheth, Sethia and Srinivas, 2011). The most well known and used definition of sustainability is "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs," as taken from the World Commission on Environment and Development (Chabowski, Mena and Gonzalez-Padron, 2011; Huang and Rust, 2011; Closs, Speier and Meacham, 2011).

It emphasizes the importance of environmental quality and the conservation of nature's assets in consumption (Huang and Rust, 2011). However we may define Sustainability to the Triple Bottom Line, a perspective based on three important dimensions: environmental quality, social equity, and economic prosperity (Chabowski, Mena and Gonzalez-Padron, 2011; Sheth, Sethia and Srinivas, 2011).

A sustainable food system provides healthy food at affordable prices that are competitive with low-cost, high-calorie foods; ensures that all residents can walk, bike or take public transit to a full grocery store; Minimizes the environmental impact of food production and transport, including greenhouse gas emissions, water consumption and chemical fertilizer and pesticide use; Is socially equitable and provides local jobs that have fair working conditions and wages (www.nlc.org/documents/sustainability)

Past Scenario

According to Cornell University food and brand lab, on average, diners leave 17% of their meal eaten and 55% of edible leftovers are left at restaurant. Approximately 4-10% of food purchased by restaurants is wasted before reaching the consumers. Drivers of food waste at restaurant include oversized portions, inflexibility of chain store management and extensive menu choices. It is because the customer demand more in less money and hence the portion sizes has increased significantly over past 30 years, often being 2-8 times larger than USDA or FDA standard servings. Kitchen culture and staff behaviour is to over prepare food. Improper storage of ingredients and failure to use food scraps and trimmings had also contributed to food loss. Buffets are wasteful since extra food can't be legally reused or donated due to health code restrictions. The common practice of keeping buffets fully stocked during business hours (rather than allowing items to run out near closing) creates even more wastage.(www.sustainabletable.org/food-waste) .

Under the UN's Save Food initiative, the FAO, UNEP and stakeholders have defined Food waste (which is a component of food loss) is any removal of food from the food supply chain which is or was at some point fit for human consumption, or which has spoiled or expired, mainly caused by economic behaviour, poor stock management or negligence.

The Sustainable Food Systems (SFS) Programme at the Rio Conference in 2012, The 10-Year Framework for Programmes on Sustainable Consumption and Production Patterns (10YFP) was an initiative to accelerate the shift towards more sustainable food systems. The Programme focuses on priority activities such as the promotion of sustainable diets and the reduction of food losses and waste.

One such practice of serving combo meals was done at IHM PUSA in March 2016. Students were served combo meals such as Rajma Chawal, Chhole Kulche, Kadhi Chawal etc. in dining hall. It was very helpful in reducing the food wastage and simultaneously provided satiety and required nutrient to students. (Shivapuri and Misra,2016)

Present Scenario

A study by Vermeir and Verbeke, 2004 found that young consumers are more highly involved in sustainable food consumption than any other sector. Sustainable food products are perceived by many consumers to be better with regard to taste, quality, safety, and freshness. If companies can make their products desirable, consumers want to buy them, regardless of the possible higher price than a non-sustainable food product According to Chouinard, Ellison, and Ridgeway (2011), the global population is projected to grow from 6.9 billion people to nearly 9 billion people by 2050. In a report from the Global Humanitarian Forum from 2009 .If the population continues to increase as predicted, these numbers will also increase (Sheth, Sethia and Srinivas, 2011). Sustainability is generally accepted nowadays as the key success factor in the long-term business strategy of firms that incorporate sustainability into their marketing strategy are thought to have a differential competitive advantage over other companies (Crittenden, Crittenden, Ferrell, Ferrell and Pinney, 2011). As the global population continues to increase, business and consumer practices must change, because environmental issues such as climate change have become one of the greatest personal concerns for people for the next five years (Press and Arnould, 2009; Chouinard, Ellison and Ridgeway, 2011).

By 2050 the growth in global population and changing diets in emerging countries are projected to bring about a 70% increase in food demand as an average of the different possible scenarios analyzed. Simultaneously, depletion of fossil hydrocarbons will increase the demand for bio fuels and industrial materials, which may compete with food for biomass. At the same time, natural resources are being depleted and climate change is pressing the agenda. Sustainable development considerations still remain under-represented in the policy-making process. Thus, the question and practice remain on how at the same time, natural resources are being depleted and climate change is pressing the agenda. Sustainable development considerations still remain under-represented in the policy-making process. Thus, the question and practice remain on how to best create a systematic and iterative method within the policy process for ensuring that resource consumption and pressures on the environment do not increase at rates which will eventually result in human and environmental catastrophes. (http://ec.europa.eu/research/agriculture/conference/feg3_en.htm)

Sustainability as Innovation -The concept of sustainability has evolved across three eras Sustainability was first seen as an operational concern, consisting largely of defensive efforts to reduce companies' environmental footprints and cut waste. Next it shifted from cost reduction to innovation, also called Sustainability 2.0. Today the world is currently in the midst of the third era, which simply became the concept as to how business is done (Chouinard, Ellison and Ridgeway, 2011).

Food waste has rightly earned its place at the top of sustainability discussions. In April, The New York State Restaurant Association, working with Mayor Michael Bloomberg announced that more than 100 NYC restaurants have pledged to reduce restaurant food waste that gets sent to landfills by 50 percent. (foodtank.com/news/2013/06/reducing-waste-five-tips-for-creating-a-smaller-menu)

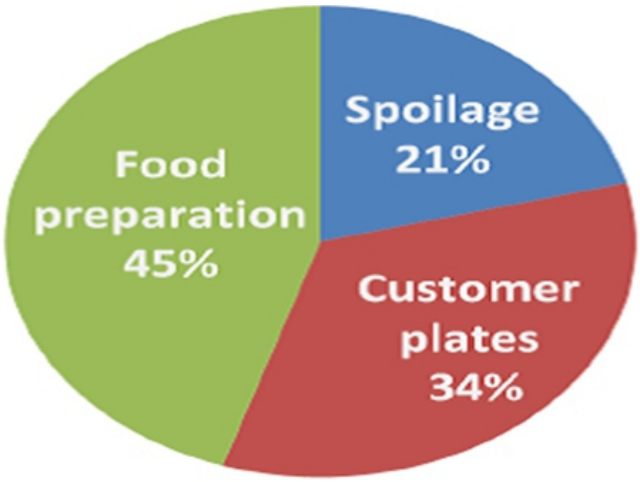
The Natural Resource Defence Council (NRDC), in 2012 affirmed that over 40% of our food is wasted system -wide, and many people have started to think twice about food waste in their daily lives. It is not just the organic matter that is being wasted, but also the energy, transportation, packaging, labour and environmental costs that go into that 40 percent. Restaurants account for a high percentage of commercial food waste, and most wasted food comes from menus that are too large and focus on variety rather than popularity. Large menus are falling out of fashion as consumers look to higher quality over a vast selection.

The theme for World Environment Day,2015 was 'Seven Billion Dreams; One Planet; Consume with Care'. The theme for World Environment Day,2015 was Think. Eat. Save. The campaign addressed the huge annual wastage and losses in food, which, if conserved, would release a large quantity of food as well as reduce the overall carbon footprint. The campaign aimed to bring about awareness in countries with lifestyles resulting in food wastage. It also aimed to empower people to make informed choices about the food they eat so as to reduce the overall ecological impact due to the worldwide production of food. (www.adb.org/news/photo-essays/world-environment-day-2015-seven-billion-dreams-one-planet-consumer-care)

Despite millions of Indians going to bed on a hungry stomach, the country is letting food worth a whopping Rs 44,000 crore go waste each year. India stands out in the world for its shocking statistics on food wastage, one third of all food produced in India is wasted. India wastes as much food as is consumed by the UK. (m.deccanherald.com/articles)

India's agriculture output in 2013-2014 reached 263mn tonnes, higher than the quantity needed to feed its population; however it has been reported that 17% of Indians are too undernourished to live, this was according to the United Nations Food and Agricultural Organization (FAO).

The Union Minister for Food Processing Harsimrat Kaur Badal blamed food wastage as a major cause for inflation and said her target was to reduce this by at least 50% in two years. She said that food worth Rs 40,000 crore is wasted annually which is almost 18% of total produce.



While the wasted fruits and vegetables alone was estimated at Rs 13,300 crore, other food products like rice, wheat, serials and meat are also allowed to perish without consumption. (DHNS).Between 15 and 20 per cent of cooked food at weddings, parties or restaurants is wasted. India produces around 250 million tonne of food grain in a year, but its annual consumption remains far lower at 220 million to 225 million tonne. The country has failed to take advantage of the higher production levels as it is reported that more than 250 million people go to bed hungry each day.(news.mit.edu/2012/sustainable-approach-to-reduceing-food-waste-in-india)

A Mid Day Meal (MDM) is an important instrument for combating class room hunger and promoting better learning. MDM is effective in improving physical and psycho-social health for disadvantaged school children in lower income and higher income countries. It increased the school attendance in lower income countries and increased the height of younger children in both lower and higher income countries. Combo meals like mithe chawal, roti sabji, kadi chawal rajma chawal, khichri and dal chawal during different days of a week. Midday meals include combo meals which are cost effective and provide required amount of nutrients to children (ICMR2010).

Emergence of combo meals: Combo meals were born out of operational necessity. Restaurants observed that customers were having difficulty quickly deciding what they wanted to order off a menu board. This resulted in long waiting lines and the loss of patrons unwilling to wait. The combo meal, made it easier to pick predetermined items for a set price. Restaurants now had fast moving lines and they were able to sell an extra item like French fries for a nominal increase in price with each order, thus improving revenues and profits. Industry spokespeople touted that restaurants offered plenty of healthier options and consumers should take responsibility for their eating decisions. Emphasis should be placed on educating Americans on a healthy diet and exercise.

Remedial Measures: The Government of Punjab started cooked meal for all students of primary classes in Government and Government aided schools of the state from September, 2004. All the schools of total twenty districts are covered under this scheme. The meal is cooked and served in the school premises. Under the scheme, school children are being provided combo food viz. mithe chawal, roti sabji, kadi chawal and dal chawal during different days of a week.(news.mit.edu/2012/sustainable-approaches-to reducing-food-waste-in-india)

There were 107 cold storage projects were approved to minimise food wastage in Union Budget 2011-12 by Honáble President of India Shri. Pranab Mukherjee. (researchgate.net/post/How to control and reduce the global food waste) 42 mega food parks have been approved by the government and will become operational by 2019, for an investment of about Rupees 14,000 cr The aim of these food parks is to establishment of a strong food processing industry backed by an efficient supply chain, which includes collection centres, a central processing centre (CPC) and cold chain infrastructure and these parks are expected to benefit about 12.5 lakh farmers and generate about 3-4 lakh jobs. (http://foodnetindia.in/blog/2015/08/20/india-curbing-food-wastage-by-setting-up-42-mega-food-parks-by-2019)

Some popular restaurants in Delhi like DumPukht, give away their leftover food to the AWB Food Bank at the end of the day. Varq, at the Taj Mahal Hotel said they give the leftover food to the NGO named Aap ki Rasoi. Zerzura said they tend to avoid any wastage of food as their place is not very big and even if there are leftovers, they give it to their employees.Mia Bella said they have a sort of per plate system so each portion is meant for one person which is why they usually don't have too much leftover food.(food.ndtv.com/food-drinks/pm-modis-mega-food-parks-to-help-curb-food-wastage-766421)

Methodology: -

Locale: The current study was conducted in CCK laboratory of IHM, Pusa. There were five combo meals planned and served in the college training restaurant, The Scholar and four Thali meals. The Combo meals included Chhole Bhature, Gatte ki sabji, Kathal Biryani, Dum Aloo Kashmiri and Chaap Masala and Thali included Kashmiri thali, Bengali thali, Haryanvi thali and Bihari thali .

Sample Size: The study was administered on faculty and Administrative staff of the institute during the lunch time in the training restaurant, The Scholar. The samples per meal are as follows:

Combo meals	Chhole Bhature	Gatte ki Sabji	Kathal Biryani	Dum Aloo Kashmeeri	Chaap Masala
Sample size	14	15	8	14	21

Thalis	Kashmiri	Bengali	Haryanvi	Bihari
Sample size	10	7	14	9

The Combo meals were tasted by 72 faculty and staff members and their views were recorded, whereas only 40 people tasted Thalis because as per them the portions was large and there would be wastage of food. Thus Combo Meals were preferred over Thalis.

Tools and Technique: Five combo meals and four Thalis were prepared during the kitchen session of 3rd semester students. These dishes were sensory evaluated. Sensory Evaluation form was developed covering- Taste, Flavour, Texture, Consistency, Color, Presentation and Sensory Attributes Were- Excellent, Good, Satisfactory And Needs Improvement. Costing for both the thalis and combo meals was also calculated. All the prices of ingredients used in meals were taken from store of Ihm Pusa.

Results: -

The five combo meals developed were Chhole Bhature, Gatte Ki Sabji, Kathal Biryani, Dum Aloo Kashmiri And Chaap Masala And four thali were from Kashmiri, Bengal, Haryana and Bihar.

72 people tasted combo meals and sensory evaluated them, whereas only 40 people tasted Thali and sensory evaluated it. After the sensory evaluation it was seen that most of the faculties preferred Combo Meals On Thalis. According to 40 people the portion size was large for them to finish the Thali which would result in wastage of food.

Moreover when costing was calculated, it was seen that most of the combo meals costed less than Rs.1000/-, whereas the costing of Thalis went high and crossed Rs.1000/- on an average for 15 persons.

Sensory Evaluation : The following graph shows the feedback from the Sensory Evaluation form where in the Faculties were to evaluate the food on the criteria's like Taste , Texture ,Aroma, Consistency, Presentation on the range of Excellent, Good, Satisfactory and Needs Improvement, Suggestions and comments.

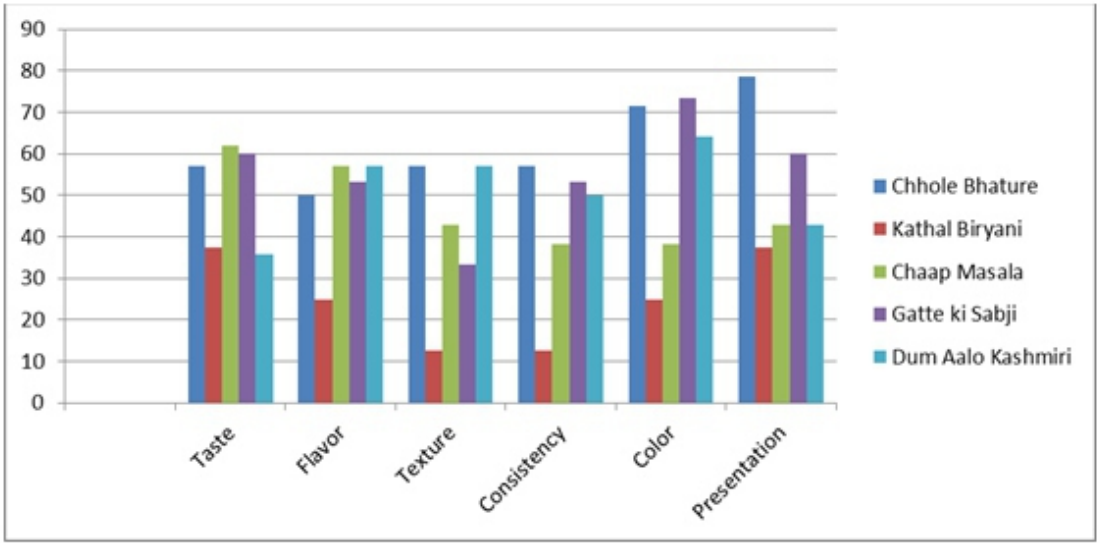


Figure 1: Sensory Evaluation of Combo Meals

It was clear from above graph that out of all the meals taste wise Chaap Masala (62%) was considered as best for its taste, again Chaap Masala and Dum Aloo Kashmiri with 57.1% were liked by faculties for their flavours, Chhole Bhature and Dum Aaloo Kashmiri with 57.1% were liked for their texture, Chhole Bhature with 57.1% for consistency, Gatte ki Sabji with 73.3% for its color and Chhole Bhature for its presentation with 78.6%. Thus Chhole Bhature was considered best combo meal with respect to texture, consistency and presentation.

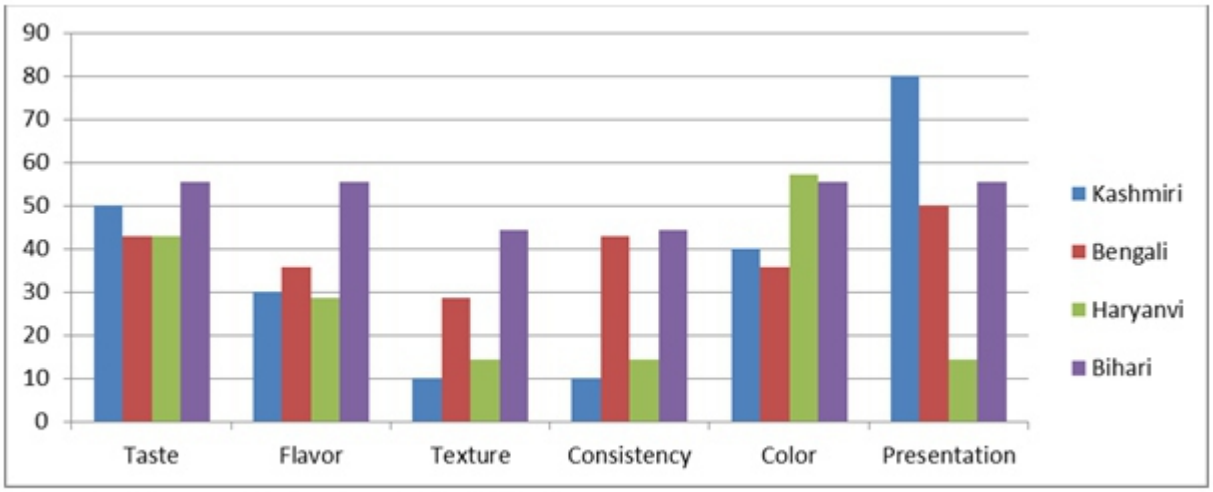


Figure 2: Sensory Evaluation of Thali Meals

The above graph shows that out of all the Thalis tasted, Bihari was considered best for its taste and flavour with 55.5% likes, for texture and consistency with 44.4%; but in colour Haryanvi Thali was liked as with 57.14%, whereas for presentation Kashmiri Thali had highest likes with 80%.

In the table1 costing of combo meals is given for which the rates were taken from the stores of IHM, Pusa

Table 1:Costing of Combo Meals for 15 persons.

MEAL	COST (Rs.)
1 Gatte ki Sabji, Batiya, Lahsun Ki Chutney and Moong Dal ka Halwa	502.70
2 Kashmiri Dum Aaloo, Naan, Seviyan and Mirchi Ka Aachaar	642.05
3 Kathal Biryani, Biryani Gravy, Burhani Raita and Rasmalai	671.60
4 Chhole, Bhature, Laccha onions, Pineapple Raita and Kulfi Falooda	983.00
5 Soya Chaap, Parantha, Laccha onions and Gulab Jamun	851.00

Table 2 is the costing of Thali meals for which the rates were taken from the stores of Ihm Pusa

Table 2: Costing of Thali Meals for 15 persons.

MEAL	COST (Rs.)
1.Kashmiri	3208.30
2. Bengali	3516.00
3 Haryanvi	1396.50
4. Bihari	2657.25

On an average, one whole combo meal was costing Rs.730 for 15 portions; therefore cost for one portion is approximately equal to Rs.48.60. Whereas average cost of one thali meal was Rs.2694.50 approx. for 15 portions; therefore cost for one portion was Rs.179.60. After comparing both these costs, it was found that Rs.131 per meal, per day was saved. Thus in an institution like IHM, Pusa having approximately 1000 students/ day for lunch, we can save about Rs1,31,000 per meal/ per day. The study also found that the portion size of Thali was large which would have resulted in wastage of food.

Conclusion :

The combo meals prepared for restaurant service during the study were Chole Bhature, Kathal Biryani with Raita,Gatte ki Sabji with Parantha, Chap Masala with Naan and Kashmiri Dum Aloo with Laccha parantha and Thalis were from Kashmiri, Bengal, Haryana and Bihar. After the sensory evaluation it was seen that most of the faculties preferred combo meals on thalis especially because of the portion size. Costing of combo meals was also much less and was benefitting the institute in saving resources. Such practices can be adopted in institution and organisations where mass feeding is done. This kind of practice will help us to save resources and be sustainable in our approach in utilizing the available resources to its best.

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Mutation Breeding For Crop Improvement

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ABSTRACT

In the present scenario of sky high population, depleting arable land and water resource, erratic rainfalls global food insecurity is a major challenge to the human existence. The food insecurity is further facilitated by the major climatic change that plays a pivotal role in reducing the food production. The development of climate smart varieties may help in increasing the food productivity by their wider adaptability to range of ecosystems. The most viable approach to develop the climate smart varieties is the mutation breeding which creates the genetic variability by modifying a single gene without altering the entire genome. The development of crop varieties which can withstand the climatic change and other environmental fluctuations can play a vital role to combat global food insecurity This article highlights the role of mutation breeding in crop improvement and thus overcoming the challenges of food security due to rising population

Key words: mutation, climate smart varieties, food insecurity

1. Introduction

According to the Food and Agriculture Organization of the United Nations (FAO), world's population is expected to increase 30% by 2050. So, there is requirement of 70% more production of food to meet the demand of increasing population which in turn is going to put an immense pressure on existing climate and agricultural yield.This puts an unprecedented demand on already climate and resource threatened agricultural productions. To overcome this situation FAO (2011) recommended establishment of low-input agriculture in 21st Century through generation of improved crop varieties that are genetically diverse, climate change resilient, input use-efficient, high yielding, enhanced nutritional attributes and better adaptable to a range of agro-ecosystems and farming practices. The extreme narrow genetic base of the available crop varieties is the major constraint for breeding desirable crop varieties that are suitable for enhancing the farm productivity and establishing food security (Khursheed et al., 2017). Mba et al., (2012) advocated the advantage of induced mutagenesis for creating genetic variation in the agro-economic traits which are required for meeting the needs of 21st Century. The enhancement in the crop productivity to ensure food security is a major challenge. The main obstacles to increase in crop production are the erratic climate change, depleted arable land and reduced water resources which play

a critical role in reducing the global crop productivity (Parry et al., 2005). Global climate climatic change is the prime threat to the crop productivity and a challenging task to the plant breeders and hence crop improvement programmes need to develop varieties which are high yielding and climate change resilient (Raina et al., 2016, Laskar et al., 2018). There is a need of development of new crop varieties having high yield and water use efficiency, rich in nutrient and also which can withstand the climatic change and other environmental fluctuations (Powlson et al., 2005, Reynolds et al., 2009, Lea and Azevedo, 2006, Richards, 2000). Several breeding methods have been employed for the creation of genetic variation in various crops, however, mutation breeding have been considered as the coherent tool for the induction of genetic variation. The concept of mutation breeding for the crop improvement was initiated in 1902 by Huge de Vries later on Morgan (1910), Muller (1927) in Drosophila, Stadler (1928) in barley and Goodspeed (1929) in Datura and Nicotiana employed mutation breeding on larger scale. Currently mutation breeding is a well established technique for crop improvement and has been credited with the development and official release of more than 3200 mutant varieties worldwide (Table 5 and 6). These mutant varieties have been developed by employing various mutagens in a wide range of plants (Table 3, 4 Fig. 1). Mutations, induced by physical include deletion of DNA and alteration in chromosome structure. By contrast, chemical mutagens tend to induce point gene mutations.

1.1. Mutations Arise In Two Ways:

(i) Spontaneous mutation that occur without treatment of the organism with an exogenous mutagens. Spontaneous mutations account for the 'background rate' of mutation and are presumably the ultimate source of natural genetic variation that is seen in populations. Spontaneous mutations can occur because of replication errors, spontaneous lesions and transposition of transposable elements during the normal growth of the cell. Spontaneous mutation is very rare and recessive.

(ii) Induced mutation are induced by the treatment of an plant or any plant part such as seed, stem cuttings, pollen and ovules with the mutagens. As the frequency of spontaneous mutation is very rare and insufficient to meet the demanding requirements of crop improvement. This slow pace of spontaneous mutation necessitates the induction of mutations artificially through mutation breeding.

1.2. Types Of Mutation:

There are two types of mutation

a) Micromutations – These involve changes in quantitative traits and can be measured at the level of population. Micromutations produce genetic variability in quantitative traits of the crops hence, the plant breeder give full attention on micromutations.

b) Macromutations – These involve large changes in the characters and can be detected without instrumental help and can be measured at the level of individual plant.

1.3. Types Of Mutagens:

In genetics, a mutagen is a physical or chemical agent that changes the genetic material, usually DNA, of an organism and thus increases the frequency of mutations above the natural background level. They may be grouped into two broad categories – physical mutagens and chemical mutagens. The mutagenic agents vary in ease of use, safety issues, and effectiveness in inducing certain genetic alterations, suitable tissue, and cost, among other factors. They may act directly on the DNA, causing direct damage to the DNA, and most often result in replication error. Many mutagens are not mutagenic by themselves, but can form mutagenic metabolites through cellular processes. Such mutagens are called promutagens. Broadily mutagens are classified in two types:

1) Physical mutagens.
2) Chemical mutagens.

1.3.1. Physical mutagens

Physical mutagens are electromagnetic radiations such as gamma rays, X- rays, UV ryas, α-rays, β-rays and fast neutrons neutrons. They are highly penetrating. However, UV rays are non ionising radiation with low penetration capacity generally induce dimer formation and deamination of DNA bases. The characteristics of physical mutagens are furnished in table 1.

Table: 1. Characteristics of mutagens

Mutagen	Characteristics
X-rays	Electromagnetic radiation; ionising, penetrate tissues from a few millimeters to many centimeters.
Gamma rays	Electromagnetic radiation, ionising, very penetrating into tissues; sources are Co^{60} and Ce^{137}
Neutrons	Uncharged particles; penetrate tissues to many centimeters; source is U^{235}
Beta particles	Negatively charged electrons; ionize; shallowly penetrating; sources P^{32} and C^{14}
Alpha particles	a helium nucleus capable of heavy ionization; very shallowly penetrating
Protons	Positively charged particles; penetrate tissues up to several centimetres

1.3.2. Chemical mutagens

Chemical mutagens are easy to use, readily available, no requirement of irradiation chambers and can provide a very high mutation frequency have gained wide popularity in mutation breeding programmes. Compared to physical mutagens, chemical mutagens tend to cause single base-pair (bp) changes, or single-nucleotide polymorphisms (SNPs) as they are more commonly referred to, rather than deletions

and translocations (Sikora, 2011).Chemical mutagens have been successfully employed in mutation breeding programmes to artificially generate variations for development of new varieties with improved traits, such as increased yield, reduced plant height and resistance to disease (Goyal et al., 2009; Tantray et al., 2017; Khursheed et al., 2015). The characteristics of chemical mutagens are depicted in table 2.

Table: 2. Chemical mutagen types and their mode of action. Source: Redrawn from van Harten, 1998

Mutagen Group	Examples	Mode of Action
Base analogues	5-bromouracil, 5-bromodeoxyuridine	Deletion, addition, frame shift
Related compounds	Maleic hydrazide, 8-ethoxy caffeine	Chromosome breaking
Antibiotics	Actinomycin D, mitomycin C, streptonigrin	Chromosome breaking
Alkylating agents: Sulfur mustards Nitrogen mustards Epoxides Ethyleneimines Sulfonates, etc Diazoalanes Nitroso compounds	 Ethyl–2-chloroethyl sulfide 2-chloroethyl-dimethyl amine Ethylene oxide Ethyleneimine Ethyl methane sulfonate (EMS), diethylsulfonate (DES) Diazomethane *N*-ethyl-*N*-nitroso urea	alkylate various sites in DNA
Azide	Sodium azide	Gene mutation
Hydroxylamine	Hydroxylamine	Base pair transition
Nitrous acid	Nitrous acid	AT ↔ GC, GC ↔AT
Acridines dyes	Acriflavin, Proflavin	AT ⟷ GC
Intercalating agents	ethidium bromide and proflavine daunorubicin	block transcription and replication

Table 3. Number of mutant varieties developed by physical mutagens
Data source: FAO mutant variety database February 2018.

PHYSICAL MUTAGENS	No. of mutant
Gamma rays	1630
X-rays	561
Gamma rays chronic	89
Fast Neutrons	54
Thermal Neutrons	50
Aerospace	46
laser	26
neutrons	24
Ion beams	17
Beta rays	16
Gamma and X-rays recurrent	9
Soft X-rays	6
X-rays or fN	5
Carbon ion beams	3
Accelerated ageing	3
Gamma rays and microwave	3
32P	2
Electrons	2
32P and Gamma rays	1
Gamma rays and mixed neutrons	1
Gamma rays and neutrons	1
Gamma rays recurrent	1
protons	1
ultrasound	1
Uv-rays	1
Gamma rays+ fN	1
Chronic X-rays	1
	Total=2555

Table: 4. Number of mutant varieties developed by chemical mutagens
Data source: FAO mutant variety database February 2018.

CHEMICAL MUTAGENS	No. of mutant
EMS	106
NEU	57
Colchicine	46
NMU	46
EI	36
DMS	19
dES	14
NaN_3	11
MNU	7
MNH	6
NENG	5
Tissue culture induced	4
NMU+dioxane	3
Arsenic-q	2
NMU +NEU	2
NMU+ DAB +dioxane	2
DES+PYM	2
PMS	2
NMH	2
Ethyleneoxide	2
AA+DAB	1
BEO(Beryllium Oxide)	1
Bromodeoxyuridine	1
DMS+DAB+dioxane	1
DMSO	1
Diazoacetylbutane	1
EMS+DAB	1
ENH	1
Extract of Datura seeds	1
NDEU	1
NDMU	1
NEU+dioxane	1
NEU+NMU+DES+DMS+EI	1
NMU+EI+DMS	1
NTMU	1
NMU and EI	1
Sodium azide	1
	Total=392

Fig.1.Percent of a number of officially released mutants across various Continents)
Data source: FAO mutant variety database February 2018

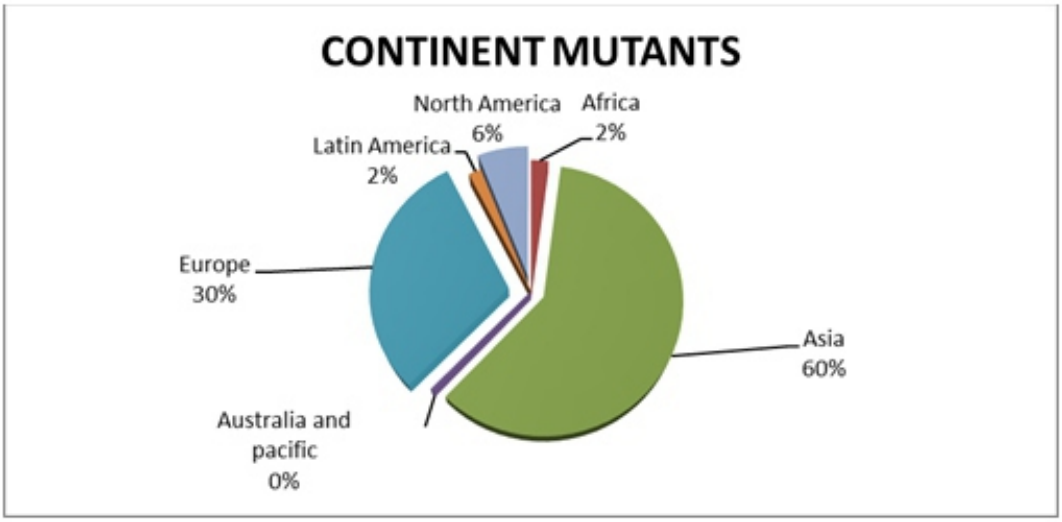

Table 5. Number of mutants developed in several countries. Data source: FAO mutant variety database February 2018

Countries	Number Of Mutants
China	810
Japan	479
India	335
Netherlands	176
United States	139
Germany	171
Bangladesh	70
Pakistan	57
Canada	40
France	39
Indonesia	29
Iran	24
Austria	17
Brazil	13
Turkey	10
Egypt	9
Australia	9
Myanmar	8
Malaysia	7
Mexico	5
Sri Lanka	4
Spain	3
Zambia	2
Switzerland	1

Table 6.Number of mutant varieties developed in cereals and legumes. Data source: FAO mutant variety database February 2018

Latin name	Number of mutants released
Cereals	
Avena sativa(Oat)	23
Hordiumvulgare(Barley)	309
Oryza sativa (Rice)	821
Secale cereal (Rye)	4
Triticumaestivum(Bread wheat)	255
Triticumturgidum(Durum wheat)	31
Zea mays (Maize)	96
	Total =1539
Legumes	
Arachis hypogea (Groundnut)	76
Cajanuscajanus(Pigeon pea)	7
Cicerarietinum(Chickpea)	27
Dolichus lablab (Hyacinth bean)	1
Lathyrussativus(Grass pea)	3
Lens culinaris(Lentil)	18
Glycine max (Soybean)	173
Phaseolus vulgaris (French bean)	59
Pisumsativum(Pea)	34
Trifoliumalexadrinum(Egyptian clover)	1
T. incarnatum(Crimson clover)	1
T. pratenus(Red clover)	1
T. subterraneum(Subterranean clover)	1
Viciafaba(Faba bean)	20
Vignaunguicularis(Azuki bean)	3
V. mungo(Black gram)	9
V.radiata(Mungbean)	39
V. unguiculata(Cowpea)	13
	Total =486

2. Impact of climatic change on agriculture

Agriculture is totally dependent on resources, weather and climate. Massive industrialization and a vast human population growth are posing a great threat to the existing water resources, arable land environment and germplasm resources. There are many negative impacts on world food production and rise in food price. One of the major reasons of this problem could be the impact of climatic changes such as gaseous pollution, depletion of atmospheric ozone, increase in UV-radiation level, increased atmospheric CO2, extreme variability of rainfall time and locations, irregular growing season lengths, intermittent dry spell, global warming, high temperatures, degradation of water and soil resources.

2.1. Mutation Breeding For Crop Improvement

The utilization of induced mutation in crop improvement is called mutation breeding. In mutation

breeding, desirable mutations are induced in crop plants with the use of physical or chemical mutagens (Raina et al., 2017). The variability generated through induced mutations are either released as new variety or used as the parent for subsequent hybridisation programmes. Mutation breeding programme should be clearly planned and should be large enough with sufficient facilities to screen large population (Wani et al., 2017; Raina et al., 2016). Plant breeders and farmers are under pressure to sustain food production under the climatic changes. The food prices are continuously increasing up worldwide in both developed and developing countries. There is no short way to solve the world food problem. Thus, there is a need to identify the cost effective method to sustain food production. Conventional breeding in combination with other techniques such as mutagenesis, biotechnology, genetic engineering or molecular breeding utilize local genetic resources for developing new cultivars that could handle frequent climatic changes (Amin et al., 2016). Mutation breeding are known to induce genetic variability in the crops that show higher yield and wider adaptability (Khursheed et al., 2016). Mutation breeding technique has played a major role in generation of climate smart varieties. These crop varieties have been shown to withstand wide range of environmental fluctuation. Globally millions of hectares of cultivated land has been devoted for the cultivation of this mutant crop varieties and inturn billons of revenue have been generated (Jain, 2010). The main objective of mutation breeding is to increase food production and provide sustainable nutrition (Goyal et al., 2009 and Wani et al., 2011). Food security has been variously defined in economic jargon, but the most widely accepted definition is the one by the World Bank “access by all people at all times to enough food for an active, healthy life”. Like wise, the World Food Summit at Rome in 1996 also known as Rome Declaration on World Food Security [FAO] on food plan action observed that, "Food security at the individual, household, national and global level exists where all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". The mutant varieties have been grown on large scale by farmers in their fields, and increase in food production resulted from cultivation of the mutant varieties could be translated into increased food security, since this would be accessible for the people in need.

3. Conclusion

The availability of accessible genetic variation is highly important to initiate crop improvement programme, the plant breeding supplemented with induced mutagenesis has proved to be coherent and robust. Induced mutagenesis is one of the most powerful breeding tools for creating novel genetic variation and accelerating the process of trait selection. Over the last several decades, mutation breeding is successful in developing large number of mutants with improved agro-economic traits of diverse plant species. The technique has been successfully applied in cereals, pulses, medicinal, horticulture plants and fodder crops etc. The different traits of interest like yield, physiological activity, nutritional

quality, secondary metabolites, plant biomass etc. has been targeted and improved through mutation breeding. With the advent of modern biotechnological tools and genetic markers, the unbound possibilities of mutation breeding are expanding. In future, it is highly recommended to integrate molecular advancement into the mutation breeding programmes for improving the selection accuracy and target trait specificity.

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