"A COMPARATIVE ANALYTICAL STUDY OF PREPERATION OF RICE AND MOONG DAL IN CONVENTIONAL METHOD AND TRADITIONAL METHOD AS DESCRIBE IN KSHEMA KUTUHAL"

Dr. Sasmita Tripathy[1]*, Dr. Arun Kumar Das[2], Dr. Manas Ranjan Hota[3], Dr. Ramesh Singh Pal[4], Dr. Anandita Pandey[5], Dr. Sadhana Sahu[6]

[1]Reader, Department of Swasthavritta and Yoga, Shri N.P.A. Government Ayurveda College, Raipur-492010, Chhattisgarh, India Email: sasmita1980@gmail.com, Orcid id: 0009-0009-8080-4001

[2]Principal, KATS Government Ayurvedic College, Ankushpur, Ganjam-760011, Odisha, India Email: dasarun1969@gmail.com

[3]Principal, Bharti Ayurved Medical College and Hospital, Pulgaon Chowk, Durg-491001, Chhattisgarh, India, Email: vaidyamanas@gmail.com

[4]Senior Scientist, ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora-263601, Uttarakhand, India, Email: ramesh.pal@icar.org.in Orcid id: 0000-0003-3185-4466

[5]MD Scholar, Department of Swasthavritta and Yoga, Shri N.P.A. Government Ayurveda College, Raipur-492010, Chhattisgarh, India Email: ananditabt08@gmail.com, Orcid id: 0009-0007-3705-7130

[6]MD Scholar, Department of Swasthavritta and Yoga, Shri N.P.A. Government Ayurveda College, Raipur-492010, Chhattisgarh, India Email: sadhusahu09@gmail.com Orcid id: 0009-0001-8567-8739

*Corresponding Author: Dr. Sasmita Tripathy, Reader, Department of Swasthavritta and Yoga, Shri N.P.A. Government Ayurveda College, Raipur-492010, Chhattisgarh, India, Email: sasmita1980@gmail.com

ABSTRACT:

The present study was undertaken to assess and compare the nutritional and antioxidant profiles of Rice (*Bhakta Kalpana*) and Moong Dal (*Mudga Soopa Kalpana*) prepared using traditional (methods as described in text *Kshemakutuhala*.) and conventional methods normally practiced in Indian households cooking. With rice and dal forming the cornerstone of the Indian diet, understanding the impact of cooking techniques on their nutrient composition is vital for promoting health and well-being. This study focused on the evaluation of Total Polyphenol Content (TPP), Total Radical Scavenging Activity (RSA), Total Antioxidant Activity (TAA), macronutrients such as carbohydrates, proteins, and fats, as well as micronutrients including iron (Fe) and zinc (Zn). Samples were prepared using traditional methods and conventional methods.

Analytical results revealed highly significant differences, TPP & RSA of both rice & dal while TAA was higher in rice cooked traditionally. Macronutrient like carbohydrate and fat in traditional rice samples showed notable higher values, while trace elements such as Fe and Zn were better preserved in traditionally cooked dal samples. However, protein in rice & fat in dal showed highly significant higher values and Zn in rice & TAA in dal showed significant higher values in conventional samples. The study highlights the nutritional advantages of traditional culinary techniques and their potential in enhancing dietary quality, while also providing a comparative understanding to help optimize cooking methods in modern households.

Keywords: Antioxidant, Rice, Moong Dal, *Kshemakutuhala,* Macronutrient.

How to cite this article: Tripathy S, Das AK, Hota MR, Pal RS, Pandey A, Sahu S. A Comparative Analytical Study of Preparation of Rice and Moong Dal in Conventional Method and Traditional Method as Describe in Kshema Kutuhal. Int J Drug Deliv Technol. 2026;16(71s): 1352-1359. DOI: 10.25258/ijddt.16.71s.157

INTRODUCTION:

Ayurveda is the science of life, through which healthy life and longevity can be attained.[1] The primary aim of Ayurveda is to maintain the health of a healthy individual and to cure the aliments of those who are diseased.[2]

In the field of preventive medicine, Ayurveda holds Greate potential. Many diseases can be prevented by following a proper diet and life style. "Prevention is better than cure" is the foremost aim of Ayurveda. Many diseases can be prevented by following proper diet & life style. Among them diet plays key role as health depends upon the type of food consumed by an individual.

Acharya Charak has mentioned *Aahar* (A balanced diet), *Nidra* (sound sleep) and *Bramhacharya* (Interaction with the internal & external world) as

the *Trayopasthambas* (Three external Sub-pillars of body) of life.[3] The entire life of a person depends upon these sub pillars. *Acharya Charak* compared the human body with a building. If any one of these pillars is weak or defective, the building of life becomes unstable and eventually collapse. To create a stable and strong structure, the role of these foundational pillars is undisputed.

Therefore, *Acharya Charak* placed significant importance on these three pillars for the smooth running of life. *Aahar* is considered the best among all things that sustain life.[4] According to *Acharya Charak*, our body is the final and supreme product of *Aahar*. He says that food helps in sustenance of the life of all living beings. Complexion, clarity, good voice longevity, intelligence, happiness, satisfaction, nourishment, strength and intellect are all dependant on food.[5]

According to *Acharya Sushruta*, food enhances vitality, strength and makes our body sturdy. Food increases enthusiasm, memory, Agni, life span, lustre and *Oja* of the body. [6] In *Charak Samhita*, *Acharya Charak* clearly mentioned that, if any human being follows proper code of conduct related to intake of wholesome food, then he lives for 36,000 nights (hundred years) free from diseases.[7]

According to Ayurveda food plays an important role in establishing the phenomena of wear and tear, continues the process of growth and development and protect the body from decay and disease etc. Therefore, *Aahar* has been given the prime place and importance among all three *Trayopasthambas*. Proper *Aahar* consumed in a correct manner helps in the proper growth of the body. On other side if taken in improper manner leads to various kinds of diseases.

All types of diseases can be managed by following wholesome regimen eve without any type of medicine, conversely even hundreds of medicines cannot cure a disease in the absence of wholesome regimen. [8] Health and disease depend upon the quality and quantity of *Aahar*. [9] Therefore for healthy living, Ayurveda emphasizes consuming right kind of *Aahar* which should be healthy and nutritious.[10]

A treatise titled "*Kshemakutuhala*" written by *Pundit Vaidya Kshemasharma* in approximately 1605 CE is available which deals with *Swasthavritta* in general and *Ahara* in particular. This text was published by *Acharya Yadavji Trikamji* in 1920 through *Ayurvediya Granthamaala* and later in 1935 Dr. Indradev Tripathi wrote Manjula Hindi commentary on it.[11] This ancient text contains the description of traditional healthy food. The concepts of *Annapana* are explained in the *Charaka samhita*, *Sushruta samhita*, *Ashtangahridaya* and *Ashtangasangraha* however the focus is predominantly on the properties of substances rather than their preparatory method. But in *Kshemakutuhala* prime importance is given upon the preparatory methods.

The present study was undertaken to assess and compare the nutritional and antioxidant profiles of Rice (*Bhakta Kalpana*) and Moong Dal (*Mudga Soopa Kalpana*) prepared using traditional (methods as described in *Kshemakutuhala*.) and conventional method (normally practised in Indian households). Given that rice and dal form the cornerstone of the Indian diet, understanding the impact of cooking techniques on their nutrient composition is vital for promoting health and well-being.

AIM AND OBJECTIVE:

To analyse the nutritional value of *Bhakta Kalpana* (Rice) and *Mudga Soopa Kalpana* (Moong Dal) to be prepared according to the methods described in *Kshemakutuhala*.

MATERIALS AND METHODS:

The *Rakta Shali* variety of rice and *Mudga Dal* were procured from a local market. These raw samples were authenticated by the Drug Testing Laboratory and Research Center, Raipur, Chattishgarh. These were cooked by adopting the preparation methodology as described in the *Kshemakutuhala* and their nutritional characteristics were then assessed in comparison to control samples (rice and dal cooked using conventional methods) at Indian Council of Agricultural Research-Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICRA-VPKAS), Almora, Uttarakhand.

Method of preparation of control sample of rice:

1. One kilogram of *Rakta Shali* (Red Oryza Sativa) was rinsed several times with clear tap water until the rinse wate was clear.
2. Fourteen litters of water were boiled in an earthen over a medium flame and the rice was added.
3. Once the rice was soft and thoroughly cooked the excessive water was drained.

Method of preparation of test sample of rice: (As per *Kshemakutuhala*)

1. One kilogram of *Rakta Shali* (Red Oryza Sativa) was rinsed several times with clear tap water until the rinse water was clear.
2. Rice was toughly soaked in *Tarka*(buttermilk)
3. Fourteen litters of water were boiled in an earthen pot over a medium flame and the rice was added.
4. Afterwards 5000 ml of *Paya* (cow milk) and 100 ml of *Ghruta* (cow ghee) were added to it and cooked.
5. Once the rice was soft and thoroughly cooked the excessive water was drained.

Method of preparation of control sample of Dal:

1. Rinse 4 Tola (48 gm) *Mudga Dal* (Vigna Radiata) with clear tap water several times until the filtrate runs clear.
2. Boil 1 *Prastha* (768ml) of water was boiled in an earthen pot over a medium flame then add Dal.
3. Add 2gm each of *Saindhava Lavana* (Himalayan pink salt), *Haridra Churna* (powder of Curcuma longa),*Pippali Churna* (powder of Piper longum) .
4. Cook the *Dal* until it becomes mushy and soft.
5. Stir in 2gm each of Mustard (*Brassica juncea*) and cumin (*Cuminum cyminum*) seeds, along with 1gm of *Hingu* 2gm and *Hingu* (*Ferulaassa-foetida*) fried in cow ghee.

Method of preparation of test sample of Dal: (As per Kshemakutuhala)

1. 4 Tola (48 gm) *Mudga Dal* (Vigna Radiata) was rinsed with clear tap water for several times till clear filtrate were observed.
2. 1 *Prastha* (768ml) of water was boiled in an earthen pot on medium flame and Dal was poured in it.
3. *Saindhava Lavana* (Himalayan pink salt), *Haridra Churna* (powder of Curcuma longa), *Pippali Churna* (powder of Piper longum) 2gm each were added to it.
4. *Dal* was properly cooked till it became mushy and soft.
5. *Dal* was churned with 20gm of curd prepared from cow milk.
6. Mustard (*Brassica juncea*) seeds 2gm, cumin (*Cuminum cyminum*) seeds 2gm and *Hingu* (*Ferulaassa-foetida*) 1gm fried in cow ghee were poured in it.

Proximate analysis

Five grams of samples from each preparation were ground into a fine powder, the ground samples were stored in desiccators. Nitrogen content was estimated by using the Kjeld Hal method (AOAC, 2005) based on the assumption that plant proteins contain 16 g of nitrogen per 100gm. Protein content was calculated using the formula, protein = nitrogen×6.25. Carbohydrate (CHO) content was determined calorimetrically using the enthrone method (Hedge and Hofreiter, 1962) [12]. The gravimetric method by Bligh and Dyer (1959) was used for determination of total fat content.

Antioxidant metabolite and activities

Each sample (1.0g) was extracted by adding 20 mL of 80 % methanol with continuous stirring at 25-degree centigrade then filtered through Whatman No. 1 filter paper. The extract solution was stored at 4 degrees centigrade to determine the total phenolic content and antioxidant activity.

Determination of total polyphenols,

Total polyphenol content (TPC) was estimated by a colorimetric assay based on procedures described by Singleton and Rossi with some modifications. Initially, 1.0 ml of methanolic extract (20 mg/ml) was mixed with Folin _Ciocalteu phenol reagent (1.0 ml). After 3 min, 1.0 ml of a saturated sodium carbonate solution was added to the mixture, and the volume was adjusted to 10 ml with distilled water. The reaction was kept in the dark for 90 min, after which the absorbance was read at 725 nm (Thermo scientific chemitospectra scan UV 2600 spectrophotometer). Gallic acid was used to calculate the standard curve (1–80 µ g/ml). The results were mean values ± standard deviations and expressed as mg of gallic acid equivalent (GAE)/g of extract.

Determination of radical scavenging activity on DPPH

Radical scavenging activity (RSA) was determined by measuring the decrease in absorbance of methanolic DPPH solution at 515 nm in the presence of the extract. An aliquot methanolic extract (150 µ L with 2850 µ L of reagent) was allowed to react with the DPPH working solution for 24h in the dark, and absorbance was recorded at 515 nm.

Determination of total antioxidant activity

The total antioxidant activity (TA) was estimated using the phospho-molybdenum method based on the reduction of Mo (VI) to Mo (V) by the sample analyte and subsequent formation of specific green phosphate/Mo (V) compounds. A 0.3 ml aliquot of extract solution (5–25 mg/ml) was combined with 2.7 ml of the reagent solution (0.6 M sulfuric acid, 28 mM sodium phosphate and 4 mM ammonium molybdate). The mixture was capped and incubated in a boiling water bath at 95 ◦C for 90 min. Samples were allowed to cool to room temperature, and absorbance was measured at 695 nm. For the blank, 0.3 ml methanol/double distilled water was mixed with 2.7 ml of the reagent. A standard curve of Trolox (10–100 µM) was prepared, and total antioxidant activity was expressed as µM Trolox equivalent/g dry weight (µM TE/g DW).

Micronutrient content

Micronutrient profiling was conducted on whole grains as per Jackson (1969) [13]. Samples were not touched with any metallic things, proper handling

subsequently cleaned to ensure the meticulous avoidance of dust or metal contamination in the seed samples. Ground samples of 100 mg were digested in triplicate using a di-acid mixture of HClO4 and HNO3. The digested extract was adjusted to a final volume of 50 mL using a volumetric flask and subsequently filtered through Whatman No. 42 paper. The samples were analyzed using an inductively coupled plasma optical emission spectrometer (ICP-OES; model 5110, Agilent Technologies, Santa Clara, CA, USA), calibrated with standard solutions.

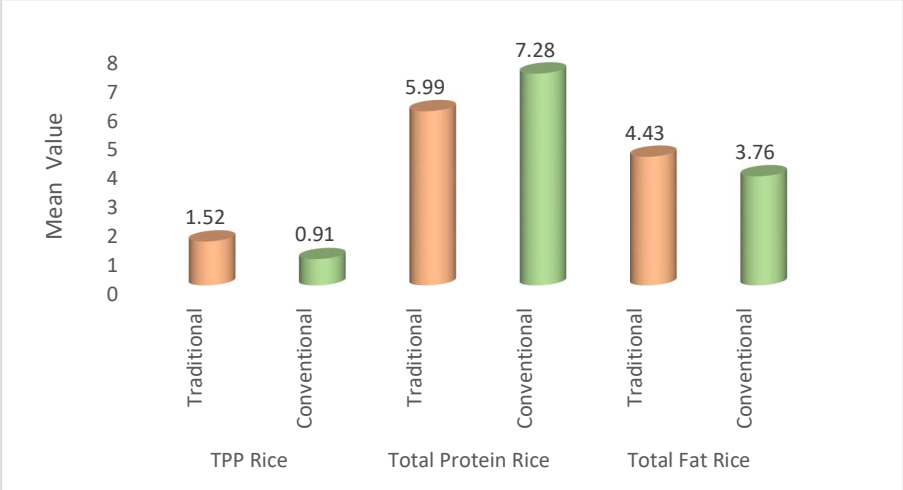
STATISTICAL ANALYSIS:

An Independent Sample t- test was applied to determine the significance of the differences between the selected control Rice and Dal preparations.

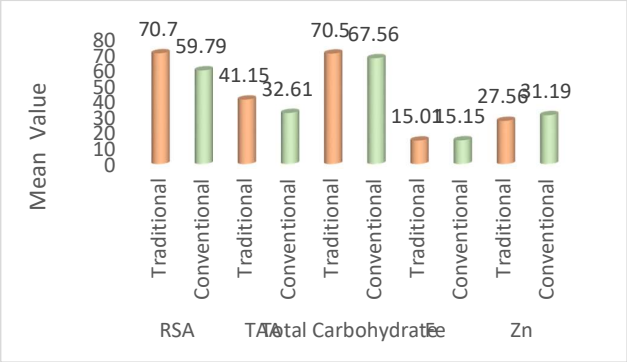
RESULTS:

Name of the sample		**1.Rice prepared in Traditional method**	**2.Rice prepared in conventional method**	**3.Dal prepared in Traditional method**	**4.Dal prepared in conventional method**
Total polyphenol(TPP)(mg GAE/g)	R1	1.36	0.85	1.52	0.75
	R2	1.68	0.97	1.41	0.87
RSA on DPPH %inhibition	R1	73.54	61.37	81.35	56.37
	R2	67.85	58.21	78.64	52.38
Total antioxidant activity (TAA)(Mm Trolox equivalent/g dw)	R1	43.62	31.54	46.38	52.38
	R2	38.67	33.67	49.87	59.67
Total carbohydrate %	R1	69.68	66.57	55.62	56.38
	R2	71.32	68.54	54.87	61.38
Total protein %	R1	5.67	6.98	8.67	10.23
	R2	6.32	7.58	9.54	9.42
Total fat %	R1	4.51	3.65	5.37	5.98
	R2	4.34	3.87	5.46	5.72
Fe PPM	R1	13.563	15.45	31.25	27.68
	R2	16.45	14.85	28.68	25.68
Zn PPM	R1	R1-	32.74	37.85	35.68
	R2	26.45 28.67	29.64	39.45	34.85

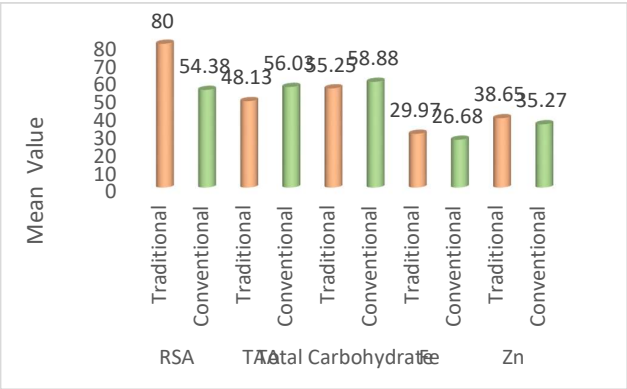
Variable	Method	Mean	S D	t value	p value	Remark
TPP Rice	Traditional	1.52	0.16	6.183	0.003	HS
	Conventional	0.91	0.06			
Total Protein Rice	Traditional	5.99	0.33	5.025	0.007	HS
	Conventional	7.28	0.3			
Total Fat Rice	Traditional	4.43	0.09	8.305	0.001	HS
	Conventional	3.76	0.11			



Variable	Method	Mean	S D	t value	p value	Remark
TPP Dal	Traditional	1.47	0.06	14.454	0.000	HS
	Conventional	0.82	0.06			
Total Protein Dal	Traditional	9.11	0.44	2.098	0.104	NS
	Conventional	9.83	0.41			
Total Fat Dal	Traditional	5.42	0.05	5.455	0.005	HS
	Conventional	5.85	0.13			
Variable	**Method**	**Mean**	**S D**	**t value**	**p value**	**Remark**
RSA Rice	Traditional	70.70	2.85	5.805	0.004	HS
	Conventional	59.79	1.58			
TAA Rice	Traditional	41.15	2.48	5.490	0.005	HS
	Conventional	32.61	1.07			
Total Carbohydrate Rice	Traditional	70.50	0.82	3.978	0.016	S
	Conventional	67.56	0.99			
Fe Rice	Traditional	15.01	1.45	0.168	0.875	NS
	Conventional	15.15	0.30			
Zn Rice	Traditional	27.56	1.11	3.298	0.030	S
	Conventional	31.19	1.55			



Variable	Method	Mean	S D	t value	p value	Remark
RSADal	Traditional	80.00	1.36	18.400	0.000	HS
	Conventional	54.38	2.00			
TAADal	Traditional	48.13	1.75	3.386	0.028	S
	Conventional	56.03	3.65			
Total Carbohydrate Dal	Traditional	55.25	0.38	2.489	0.068	NS
	Conventional	58.88	2.50			
FeDal	Traditional	29.97	1.29	3.496	0.025	S
	Conventional	26.68	1.00			
Zn Dal	Traditional	38.65	0.80	6.502	0.003	HS
	Conventional	35.27	0.42			



DISCUSSION:

The present study compared the nutritional composition and antioxidant properties of rice and moong dal prepared using traditional and conventional cooking methods. The evaluated parameters included total polyphenol content (TPP), radical scavenging activity (RSA), total antioxidant activity (TAA), carbohydrate, protein, fat, iron (Fe), and zinc (Zn) contents. The results showed the considerable variations among the cooking methods, indicating that the method of preparation significantly influences the nutritional and functional quality of the food.

Total Polyphenol Content (TPC)

The highest total polyphenol content was observed in rice prepared by the traditional method (1.52 mg GAE/g), followed closely by traditionally prepared dal (1.465 mg GAE/g). In contrast, conventionally prepared rice and dal showed lower values of 0.91 and 0.81 mg GAE/g, respectively.

The higher polyphenol content in traditionally prepared samples may be attributed to lower thermal degradation and reduced leaching of phenolic compounds during cooking. Polyphenols are important bioactive compounds possessing antioxidant properties, and their retention indicates superior preservation of nutritional quality under traditional cooking conditions.

Radical Scavenging Activity (RSA)

The RSA measured through DPPH inhibition assay showed that traditionally prepared dal exhibited the highest antioxidant potential (79.995% inhibition), followed by traditionally prepared rice (70.695%

inhibition). Conventional preparation resulted in considerably lower RSA values, particularly in dal (54.375% inhibition)

RSA are the metabolites responsible for free radical scavenging activity. The strong positive relationship between polyphenol content and RSA further confirms the contribution of phenolic compounds to antioxidant capacity. Higher RSA in traditional samples shows that these can neutralize free radicals, like the DPPH radical effectively, thus preventing oxidative damage.[12]

Total Antioxidant Activity (TAA)

The total antioxidant activity ranged from 32.605 to 56.025 mM TE/g dry weight. Interestingly, conventionally prepared dal recorded the highest TAA value (56.025 mM TE/g dw), followed by traditionally prepared dal (48.125 mM TE/g dw). Traditionally prepared rice also exhibited higher antioxidant activity (41.145 mM TE/g dw) compared with conventionally prepared rice (32.605 mM TE/g dw).

Highly significant TAA in traditional samples improves potential of the health benefits by preventing chronic diseases. Highly significant TAA also suggests that the traditional method helps in preserving the antioxidants better than the conventional methods. However, overall antioxidant characteristics, when considered together with TPP and RSA, favoured traditional preparation methods.

Total Carbohydrate:

Carbohydrate content was highest in traditionally prepared rice (70.50%) and lowest in traditionally prepared dal (55.245%). Conventional cooking reduced carbohydrate content in rice to 67.555%, whereas it increased slightly in dal to 58.88%. Rice naturally contains higher carbohydrate levels than legumes; therefore, these observed differences are expected. The slight reduction in carbohydrate content in conventionally cooked rice may result from starch breakdown or greater solubilization during cooking.

Total Protein:

content was considerably higher in dal than in rice irrespective of the cooking method. Conventionally prepared dal recorded the highest protein content (9.825%), followed by traditionally prepared dal (9.105%). Rice samples contained lower protein levels, ranging from 5.995% in traditional preparation to 7.28% in conventional preparation. The increase in protein percentage observed under conventional cooking may be associated with moisture loss and concentration effects during processing.

Total Fat:

Fat content ranged between 3.76% and 5.85%. Traditionally prepared rice contained more fat (4.425%) than conventionally prepared rice (3.76%). Similarly, conventionally prepared dal exhibited the highest fat content (5.85%), slightly exceeding traditionally prepared dal (5.415%). These variations may be attributed to differences in cooking duration, temperature, and moisture retention, all of which can influence the concentration of lipid fractions in the final product.

Iron (Fe):

The dal samples contained substantially higher iron concentrations than the rice samples. Traditionally prepared dal showed the highest iron content (29.965 ppm), followed by conventionally prepared dal (26.68 ppm). In contrast rice samples contained comparatively lower iron levels, with values of 15.0065 ppm and 15.15 ppm for traditionally and conventionally prepared sample, respectively. The results showed that moong dal is a richer source of dietary iron and that traditional preparation helps retain a greater proportion of this essential mineral.

Zinc (Zn):

The zinc content was highest in traditionally prepared dal (38.65 ppm), followed by conventionally prepared dal (35.265 ppm). In rice, conventional preparation resulted in higher zinc content (31.19 ppm) than traditional preparation (27.56 ppm). Overall, dal was shown to be superior source of zinc compared to rice. The variations in zinc retention may be associated with differences in cooking water absorption, leaching losses, and concentration effects during processing.

CONCLUSION:

Rice and Dal prepared using traditional culinary techniques exhibit improved shelf-life better quality maintenance and enhanced protection against, oxidative damage by neutralizing free radicals preventing chronic diseases. The study highlights the nutritional advantages of traditional methods and their potential in enhancing dietary quality, providing a comparative framework to help optimize cooking practices in Morden households.

The comparative analysis showed that traditional cooking methods generally preserved higher levels of polyphenols, antioxidant activity (RSA), carbohydrates, and iron, particularly in both rice and moong dal. Notably moong dal consistently exhibited superior nutritional quality compared to rice, especially regarding protein, iron, zinc, and antioxidant content.

Although conventional cooking enhanced certain parameters such as protein, fat, zinc (in rice), and total antioxidant activity in dal, the overall

nutritional and functional profile favoured traditional preparation methods. Therefore, traditional cooking practices offer considerable advantages by retaining bioactive compounds and essential nutrients, thereby contributing to improved dietary quality and health benefits.

REFERENCES:

1. Saylhee Deshmuk, MK Vyas (2016), concept of Nitya Sevaniya Aahardravya. Global J Res. Med. Plants & Indigen. Med, volume 5(5):173-182.
2. Dr Brahmanand Tripathi, Charak Samhita sutra sthan 30/26 vol 1 Chaukhambha publication edition 2013.
3. Brahmanand Tripathi, Pandey Ganga Sahay, Charak Samhita sutra sthan 11/34, with Charak Chandrika Hindi commentary, Chaukhambha Prakashan, 2007,238.
4. Brahmanand Tripathi, Pandey Ganga Sahay, Charak Samhita sutra sthan 25/40, with Charak Chandrika Hindi commentary, Chaukhambha Prakashan, 2007, 454.
5. Brahmanand Tripathi, Pandey Ganga Sahay, Charak Samhita sutra sthan 27/349, with Charak Chandrika Hindi commentary, Chaukhambha Prakashan, 2007, 544.
6. Ambikadutta Shastri, Sushruta Samhita, Chikitsa Sthan 24/68,136, Chaukhambha Prakashan, Varanasi, Edition 2nd, p-206
7. Brahmanand Tripathi, Pandey Ganga Sahay, Charak Samhita sutra sthan 27/348, with Charak Chandrika Hindi commentary, Chaukhambha Prakashan, 2007, 544.
8. Mangalagowri Rao, Textbook of Swasthavritta, Chapter no. 8 Page no.79, Chaukhambha Orientalia Varanasi, Edition 2014.
9. Brahmanand Tripathi, Pandey Ganga Sahay, Charak Samhita sutra sthan 25/31, with Charak Chandrika Hindi commentary, Chaukhambha Prakashan, 2007, 448.
10. PL. Shri Ram Sharma Aacharya, 108 Upnisad [Saral hindibhawarthasahit] Bhag 1, Gyan Khanda, Taitariyopnisad, Bramhanandvalli, Anuvak 2/1, page no. 204, Publication- Shantikunj, Haridwar Ed-3rd, 2002.
11. Kshemasharma, Indradev Tripathi, Kshemakutuhalam Manjula-Hindivyakhyavibhushitam, 1st edition, Chaukhamba Viswabharati-1978, p.-107
12. HedgeJ. E.HofreiterB. T. (1962). Estimation of Carbohydrate: Methods in Carbohydrate Chemistry. New York, NY: Academic Press, 17–22.
13. JacksonM. L. (1969). Soil Chemical Analysis Prentice Hall of India Pvt. Ltd., New Delhi; p. 205.