Short Communicaion

Assessment of chemical parameters of Nepalese rice varieties and imported brands

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Abstract
There has been growing import of fine and aromatic rice in Nepal in recent years. The inherent quality of different rice varieties could be one factor over consumer preference while proper packing and branding could be other factors. Most of the Nepalese rice varieties have not been able to penetrate the market as commercial brands and local landraces are gradually getting popular due to their inherent taste, aroma nutritional value. A study was conducted by the Center for Crop Development and Agro-biodiversity Conservation (CCDABC) in the year 2018/19 to compare the chemical compositions of different Nepalese rice varieties and imported brands, which were collected from major markets of different districts of Nepal. The study was aimed in understanding the chemical composition of these varieties and to know if the growing preference over imported fine and aromatic varieties had better chemical parameters over Nepalese varieties. The study revealed that higher content of zinc was observed in local varieties than in other varieties and brands. It ranged from 10.9 to 13.9 mg/kg in imported brands and from 9.7 to 17.6 mg/kg in released varieties. The highest crude protein was observed in the Dawat (12.64 %), one of the Indian brands and the lowest in Radha 4 (6.02 %) Nepalese released variety is commonly grown in the country. Average crude protein in Nepalese brands, imported brands, released varieties and local varieties were found as 11.22 %, 10.38, 8.62 % and 7.41 % respectively. Local varieties showed the highest crude fat (average 2.19 %) content followed by released varieties (average 1.17 %) and Nepalese brands (average 0.51 %). Likewise, crude fibre and total ash contents in local varieties were observed as 0.96 % and 0.93 % respectively. Therefore, the study revealed that local varieties were found superior in terms of chemical and nutritional perspective (total ash, crude fibre, crude fat and zinc) over other varieties and brands found in Nepal. In terms of protein, Nepalese brands were found superior over other varieties and brands.

Keywords: Chemical composition, iron, rice brand, variety

Introduction

Rice (*Oryza sativa* L.) is the second most widely grown cereal crop and the staple food for more than half of the world's population, providing 20 percent of the world's dietary energy supply (Alexandratos and Jelle, 2012). From this viewpoint, rice is the most important strategic crop for food and nutrition security globally. In the context of Nepal, it is the main staple food crop and contributes significantly to the livelihood of the majority of people and the national economy (nearly 20 percent contribution in the agricultural gross domestic product) (Gadal *et al*., 2019).

Rice quality is a combination of physical and chemical characteristics. Different people from different countries have different preferences for the quality and type of rice. Preference in terms of appearance, taste and texture vary from one consumer to another, some of them prefer aromatic rice and raw milled rice, others like the parboiled rice and others the most conventional rice (Martin *et al*., 1997). Similarly, Indica rice varieties that are hard but non-sticky are generally preferred in India, Pakistan, and Indonesia, while Japonica rice varieties which have moderate elasticity and stickiness are favored in Japan and Korea (Bhattacharya *et al*., 1982, Kang *et al*., 2011). Rice quality is a multi-faceted characteristic consisting of several aspects such as physical appearance, cooking and eating qualities, and nutritional value (Unneverhr *et al*., 1992). In Nepal, rice is the major staple food crop produced and consumed. With most of the population dependent on rice as a significant part of their diet, it is important to analyze and

monitor its chemical and mineral composition. This study was carried out to know the chemical compositions of different rice varieties being grown in and/or sold in different districts of Nepal and some imported rice brands available in Kathmandu and to create awareness among the researchers, extension workers and consumers.

Materials and methods

Rice (milled rice) samples were collected during March-April of 2019 from different places of Nepal. Eleven released Nepalese rice varieties from the National Rice Research Program (NRRP), Hardinath, Dhanusha, six imported and three Nepalese rice brands from mall/supermarket of Kathmandu and three local varieties of rice from different districts of Nepal were collected (Table 1) for the study. The collected rice samples were cleaned and properly packed in separate plastic (each containing at least 200 g) before sending for the lab analysis. In the case of released varieties, rough paddy samples of each variety were collected, milled and manually cleaned in NRRP, Dhanusa for preparing the sample for the same. The physical and chemical composition of each sample was analyzed in the central laboratory of the Department of Food Technology and Quality Control (DFTQC), Kathmandu, Nepal. All the methods used for analysis were carried out based on the AOAC (Association of Official Analytical Chemists) method and National Food and Feed Reference Laboratory (NFFRL) Nepal manual. All the observed data of chemical compositions from the lab test were representative of two replications for each sample.

Table 1. Different rice varieties and brands collected for the analysis

S.N.	Rice variety/Brand name	Collection place	Country	Type of rice
	Imported brands			
1	Mithas	Kathmandu	India	Premium reserve rice/Basmati
2	Lal Quilla	Kathmandu	India	Classic white line basmati rice
3	507 Gold	Kathmandu	India	Basmati rice
4	Dawat	Kathmandu	India	Super basmati rice
5	India Gate	Kathmandu	India	Basmati rice classic
6	Sunlee	Kathmandu	Thailand	Jasmine rice
	Nepalese brands			
1	Hulas	Kathmandu	Nepal	Basmati rice
2	Gyan	Kathmandu	Nepal	Fine rice
3	Jira Masino	Banke	Nepal	Fine rice
	Nepalese released varieties			
1	Sawa Masuli Sub 1	Dhanusha	Nepal	Fine rice
2	Sworna Sub 1	Dhanusha	Nepal	Medium fine rice
3	Chaite 5	Dhanusha	Nepal	Medium
4	Sabitri	Dhanusha	Nepal	Medium
5	Ramdhan	Dhanusha	Nepal	Medium rice
6	Radha 4	Dhanusha	Nepal	Coarse rice
7	Bahuguni 1	Dhanusha	Nepal	Fine rice
8	Hardinath 1	Dhanusha	Nepal	Medium fine rice
9	Makawanpur 1	Dhanusha	Nepal	Coarse rice
10	Lalka Basmati	Dhanusha	Nepal	Fine and aromatic rice
11	Khumal 4	Nuwakot	Nepal	Fine rice
	Nepalese local varieties			
1	Jumli Marshi	Jumla	Nepal	Coarse rice
2	Pokhareli Jethobudho	Kaski	Nepal	Fine aromatic rice
3	Chandannath	Kaski	Nepal	Coarse rice

Results and Discussions

Physical rice grain composition (Grading)

Rice grain grading assures that a particular lot of grain meets the required set of standards for the customer. It comprises the presence or absence of foreign organic and inorganic matter, broken rice, damaged grain, chalky kernel, red kernels etc. The observed samples showed different physical grain composition which is given in Table 2.

Table 2. Physical grain compositions of different rice varieties and brands

S. N.	Rice variety/ brand name	Foreign organic matter (%)	Foreign inorganic matter (%)	Damaged grain (%)	Broken rice (%)	Chalky kernels (%)	Red kernels (%)
	Imported brands						
1	Mithas	0	0	0.18	0	0	1.83
2	Lal Quilla	0	0	0.19	0	0	0
3	507 Gold	0	0	0.06	0	0.05	0.1
4	Dawat	0.11	0	0.25	0.37	0	0
5	India Gate	0	0	0	0	0	0
6	Sunlee	0	0	0	0.21	0	0
	Nepalese brands						
1	Hulas	0	0	0	0	0	1.06
2	Gyan	0	0	0	0.61	0.22	0
3	Jira masino	0	0	0.19	0	0	0
	Released varieties						
1	Sawa Masuli Sub 1	0.07	0	0.68	2.1	0	0.37
2	Sworna Sub 1	0.10	0	0.27	1.5	0.01	0.16
3	Chaite 5	0	0.08	0	0.24	0	0.2
4	Sabitri	0	0.87	0.08	0.13	0	0.04
5	Ramdhan	0	0.87	0	0.02	0	0.13
6	Radha 4	0	0	0	2.4	0	0.19
7	Bahuguni 1	0	0	1.10	8.6	0	0
8	Hardinath 1	0	0	3.20	6.1	0	0
9	Makawanpur 1	0	0	0.10	4.6	0	0
10	Lalka Basmati	0	0	7.90	1.9	0	0
11	Khumal 4	0	0	0.6	3.8	0	0
	Local varieties						
1	Jumli Marshi	0	0.08	0	1.4	0.3	0
2	Pokhareli	0	0	0	4.1	0	0
3	Jethobudho Chandannath	0	0	0	12.7	0	0

Source: Lab test report, DFTQC, 2019

A higher percentage of broken rice was observed in released varieties and local varieties than in imported brands and Nepalese brands. The maximum broken rice percentage was observed in Chandannath (12.7 %) whereas the lowest was observed in Ramdhan (0.02 %). Most of the imported brand and Nepalese brands showed zero percentage of broken rice whereas released varieties showed a higher percentage of broken rice but less than the standard limit of 25 % (DFTQC, 2018). Andrews *et al*. (1992) stated that one of the primary factors determining the best milling and quality of rice is the head rice which means the rice containing less amount of broken rice. The percentage of broken rice in released varieties ranged

from 0.02 to 8.6 %. This might be due to standard processing involved in branded rice but milling with manual cleaning in case of released and local rice varieties.

Foreign organic matter ranging from 0.07 to 0.11 % was observed in Dawat, Sawa masuli Sub 1 and Sworna Sub 1 only but remained below the standard limit of 0.5 % (DFTQC, 2018). Similarly, there was no presence of foreign inorganic matter in all the brands and varieties except in Chaite, Sabitri and Ramdhan. Among these three varieties, Sabitri and Ramdhan showed the presence of foreign inorganic matter more than the standard limit of 0.1 % (DFTQC, 2018). The damaged grain percentage in 4 out of 6 imported brands ranged from 0.06 to 0.25 % whereas in 8 out of 11 released varieties it ranged from 0.08 to 7.9 % for which the standard limit is 3 % (DFTQC, 2018). The higher percentage of damaged grain in released varieties might be due to poor processing and manual cleaning in the released varieties. Similarly, damaged grains in local varieties could be due to several factors like processing, drying, storing etc. or broken itself. Among all the brands and varieties presence of red kernels and chalky kernels were found below the standard limit of 4 % and 7 % respectively (DFTQC, 2018) but observed only in a few varieties and brands.

Chemical composition analysis

Each rice sample was analyzed to observe the chemical compositions like carbohydrate, energy, crude fibre, total ash, total protein, crude fat, moisture etc. which is presented in Table 3. These chemical compositions are important indicators of rice nutrient content. Rice grain is an excellent source of complex carbohydrates, protein, vitamins and minerals (Yadav and Jindal, 2007). The data showed that amount of different chemical compositions varied among the different rice varieties and brands. The highest crude protein was observed in the Dawat brand (12.64 %) which is Indian super basmati rice and the lowest in Radha 4 (6.02 %) which is a released Nepalese variety. The average crude protein content in Nepalese brands was 11.22 % whereas it was 10.38 % in imported brands. It ranged from 6.02 to 10.18 % in released varieties and from 6.88 to 7.77 % in local varieties. Protein quality is determined by the amino acid composition and its digestibility. Rice protein quality is very high when compared to other crops. Rice has a high amount of lysine and high protein digestibility (Frei and Becker, 2005). Protein in rice is of particular importance for health especially for those whose main staple food is rice. Regarding the crude fat, the highest amount was observed in local varieties (average 2.19 %) followed by released varieties (average 1.17 %) and Nepalese brands (average 0.51 %). Total ash content was found higher in local varieties (average 0.93 %) than in other varieties and brands. In the case of carbohydrate and energy content, their averages were observed as 80.49 % and 366.81 Kcal/100g respectively in imported brands, 79.51 % and 367.49 Kcal/100g respectively in Nepalese brands, 81.00 % and 369.05 Kcal/100g respectively in released varieties and 79.5 % and 367.29 Kcal/100g respectively in local varieties. FAO (1993) stated that the amount of energy of white rice varied from 349 to 373 kcal.

The amount of starch in the grain is an important factor for determining grain quality. Rice starch is digested more rapidly when compared to other starchy foods and can lead to a fast and high increase in blood glucose levels after digestion (Frei and Becker, 2005). Rice has the highest energy contribution to developing countries. In Asia, rice is the main dietary source for energy, protein, thiamine, riboflavin, niacin, iron and calcium (Juliano, 1997). The crude fibre content was found a higher range in local varieties (average 0.96 %) whereas very lower range in imported brands (average 0.14 %) and Nepalese brands (average 0.05 %). Rice has the lowest dietary fibre content when compared to other cereals (FAO 1993). Therefore, in chemical and nutritional perspectives (total ash, crude fibre and crude fat) local varieties were found superior over other varieties and brands. In terms of protein, Nepalese brands were found superior over other varieties and brands. To cope with the increasing population, food security, nutrient security, urbanization, climate change and changing food preferences, there is a need for not only high yielding varieties but also nutritionally adequate rice varieties (Salim *et al*., 2017). With regards to the moisture content, an average of 8.21 % in imported brands, 8.32 % in Nepalese brands, 8.85 % in released varieties and 9.02 % in local varieties were observed. Moisture content is important in

maintaining the quality of grain. High moisture content is associated with loss of viability, high incidence of pests and diseases, and reduction in eating quality. For best grain quality, 14 % of moisture content is recommended for rice grain (Unneverhr *et al.*, 1992).

Table 3. Chemical compositions of different rice varieties and brands

S.N	Rice variety/ brand name	Moisture %	Crude fat %	Crude protein %	Total ash%	Crude fiber%	Carbo-hydrate %	Energy (kcal/100g)
	Imported brands							
1	Mithas	6.83	0.36	11.26	0.63	0.18	80.74	371.24
2	Lal Quilla	7.75	0.06	9.08	0.55	0.08	82.48	366.78
3	507 Gold	8.33	0.27	10.33	0.59	0.16	80.32	365.03
4	Dawat	8.4	0.4	12.64	0.18	0.15	78.23	367.08
5	India Gate	7.99	0.53	10.47	0.33	0.14	80.54	368.81
6	Sunlee	9.96	0.61	8.5	0.18	0.15	80.6	361.89
	Average	8.21	0.37	10.38	0.41	0.14	80.49	366.81
	Nepalese brands							
1	Hulas	8.84	0.4	12.04	0.3	0.05	78.37	365.24
2	Gyan	9.04	0.4	10.48	0.17	0.03	79.88	365.04
3	Jira Masino	7.09	0.72	11.15	0.68	0.08	80.28	372.2
	Average	8.32	0.51	11.22	0.38	0.05	79.51	367.49
	Released varieties							
1	SawaMasuliSub1	8.65	0.95	9.55	0.48	0.34	80.03	366.87
2	Sworna Sub 1	8.28	0.73	10.18	0.35	0.1	80.36	368.73
3	Chaite 5	8.84	0.93	9.52	0.34	0.08	80.29	367.61
4	Sabitri	8.88	1.02	9.26	0.13	0.09	80.62	368.7
5	Ramdhan	8.88	1.9	9.3	0.45	0.18	79.29	371.46
6	Radha 4	8.9	1.16	6.02	0.02	0.21	83.69	369.28
7	Bahuguni 1	8.73	1.07	8.49	0.05	0.1	81.56	369.83
8	Hardinath 1	9.06	1.37	8.47	0.02	0.02	81.06	370.45
9	Makwanpur 1	8.47	0.56	6.06	0.04	0.12	84.75	368.28
10	Lalka Basmati	9.11	0.65	9.49	0.03	0.08	80.64	366.37
11	Khumal 4	9.53	2.55	8.53	0.47	0.19	78.73	371.99
	Average	8.85	1.17	8.62	0.22	0.14	81.00	369.05
	Local varieties							
1	Jumli Marshi	8.72	0.99	7.57	1.06	2.29	79.37	356.67
2	Pokhareli	9.57	2.37	7.77	0.57	0.16	79.56	370.65
3	Jethobudho Chandannath	8.76	3.2	6.88	1.16	0.44	79.56	374.56
	Average	9.02	2.19	7.41	0.93	0.96	79.50	367.29

Source: Lab test report, DFTQC, 2019

Mineral composition analysis

The iron and zinc contents of different rice varieties and brands are given in Table 4 which revealed that variation in the amount of mineral contents was observed among the varieties and brands. Average zinc content found 12.38 mg/kg in imported brand, 10.40 mg/kg in Nepalese brands, 13.28 mg/kg in released varieties and 16.37 mg/kg in local varieties. It ranged from 10.9 to 13.9 mg/kg in imported brands and from 9.7 to 17.6 mg/kg in released varieties. Higher content of zinc was observed in local varieties. Regarding iron content, all of the verities and brands had less than 8 mg/kg of iron content except local varieties. In local varieties, it ranged from less than 8 to 16.2 mg/kg.

The nutritional composition of rice grain depends on different factors such as varieties, location, soil fertility, fertilizer application, environmental conditions and post-harvest transformations (Oko *et al*., 2012; FAO, 2006). Minerals are concentrated in the outer layers of rice or the bran fraction. The distribution of minerals in rice kernels is not uniform. About 50% of the mineral content is located in the bran layer and 10% in the embryo; both will be removed when producing white rice. White rice only contains 28% of the total ash of brown rice (Hunt *et al*., 2002). Generally, the deficiency of minerals in rice is due to their low concentration and the presence of inhibitors. Research studies showed that mineral contents in rice occur at low levels and influenced by many factors. For example, iron levels in rice differ with growing regions (Liang, 2007). In other aspects, consumers are becoming more health-conscious in their choice of the quality of food. Therefore, the quality of rice does not only include the physical characteristics but also the chemical and cooking qualities of the grain. Therefore, when selecting a particular variety, there is the need to consider the nutritional value derivable from that variety (Mbatchou and Dawda, 2013).

Table 4. Zinc and Iron contents of different rice varieties and brands

S.N.	Rice variety/Brand name	Zinc (mg/kg)	Iron (mg/kg)
	Imported Brands		
1	Mithas	12.3	< 8
2	Lal Quilla	12.6	< 8
3	507 Gold	11.9	< 8
4	Dawat	10.9	< 8
5	India Gate	12.7	< 8
6	Sunlee	13.9	< 8
	Average	12.38	-
	Nepalese Brands		
1	Hulas	10.6	< 8
2	Gyan	10.5	< 8
3	Jira Masino	10.1	< 8
	Average	10.40	-
	Released Varieties		
1	Sawa Masuli Sub 1	17.6	< 8
2	Sworna Sub 1	10.2	< 8
3	Chaite 5	10.2	< 8
4	Sabitri	17.1	< 8
5	Ramdhan	14.7	< 8
6	Radha 4	10.6	< 8
7	Bahuguni 1	12.6	< 8
8	Hardinath 1	9.7	< 8
9	Makawanpur 1	17.2	< 8

10	Lalka Basmati	11.7	< 8
11	Khumal 4	14.5	< 8
	Average	13.28	-
	Local Varieties		
1	Jumli Marshi	17.6	10.1
2	Pokhareli Jethobudho	13.8	< 8
3	Chandannath	17.7	16.2
	Average	16.37	-

Source: Lab test report, DFTQC, 2019

Conclusion

In this study, differences in rice varieties and brands were reflected by the range of nutritional characteristics. No variety/brand was observed that was superior to another in terms of its overall nutritional content; however, there were some varieties/brands that recorded higher levels of one or more nutrients. Regarding the mineral content (iron and zinc), crude fibre and crude fat the local varieties found superior over branded rice and other varieties. The study showed that local and Nepalese rice varieties are superior or at par in terms of nutritional aspects like crude fat, crude fibre, carbohydrate, energy and zinc with the popular rice brands from a neighboring country. Therefore, promotional activities and branding of these varieties need to be emphasized for increasing the adoption of Nepalese varieties and import substitution. A further study to understand the preference of consumers over different varieties could give a better picture in understanding the market structure of rice.

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Study limitations

- A limited number of districts and samples were selected and collected due to limited budget allocation.
- In the case of branded rice samples, coarse varieties (branded) were excluded in the study due to their unavailability in the supermarkets and malls.

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