Bangladesh Journal of Veterinary and Animal Sciences, Vol.6, No. 1 & 2, December 2018

ISSN 2227-6416

Bangladesh Journal of Veterinary and Animal Sciences

Journal home page: www.cvasu.ac.bd/journal/userlist

Research Article

Assessment of Quality Parameters and Heavy Metal Contamination of Common Instant Noodles Sold in Bangladesh

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ARTICLE INFO

Article history :

Received : 21/12/2018

Accepted : 13/05/2019

Keywords :

Heavy metals; Instant noodles; Quality parameters

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ABSTRACT

This study was carried out to evaluate the quality parameters and heavy metal (Cd, Cr, Mn, Ni and Pb) concentration of six different brands of instant noodles available in Bangladesh. A total thirty samples from six branded instant noodles were examined to evaluate five quality parameters such as moisture content, fat content, ash content, crude protein content, carbohydrate and crude fiber content. The level of heavy metal was investigated by using Atomic Absorption Spectrophotometer (AAS). The quality analysis of instant noodles showed the value of moisture content (2.10-4.51%), fat content (15.26-17.24%), ash content (0.97-2.27%), crude protein content (8.65-17.3%), crude fiber (6.19-11.99%) and carbohydrate (54.67-62.99%). The analysis showed that there was a significant difference ($p<0.05$) in all the quality parameters examined among all the samples.The mean levels of the metals significantly ($p<0.05$) varied between 0.004 to 0.073 mg/kg for Cd, 0.0678 to 0.1204 mg/kg for Cr, 0.096 to 0.1702mg/kg for Mn, 0.0132 to 0.074mg/kg for Ni and 0.0205 to 0.1144 mg/kg for Pb, the levels of these metals exceeded minimum safe limits given by WHO except for Ni and Mn. So awareness should be taken to prevent the consecutive consumption of these heavy metal contaminated instant noodles as well as diseases associated with the accumulation of these heavy metals.

To cite this paper : *Ahmed, S., Ali, M.S., Siddiqua, A., Noor, T. and Saha, S., 2018. Assessment of Quality Parameters and Heavy Metal Contamination of Common Instant Noodles Sold in Bangladesh, Bangladesh Journal of Veterinary and Animal Sciences, 6 (1 & 2): 09-15*

1. INTRODUCTION

Instant noodles are the major staple foods in most of the countries in Asian subcontinent. Basically, noodles initiated from china first. Now instant noodles have turned extensively adopted food for everyday use. Innovative techniques have also been implemented to increase the quality of noodles and meet up the consumer demands. Wheat flour, starch, water, salt or kansui (an alkaline salt mixture of sodium carbonate, potassium carbonate and sodium phosphate) are generally used to make instant noodles. Instant noodles are partially cooked by steaming and further cooked and dehydrated by a deep frying process. Pasta and noodles, both are wheat-based products but they differ depending on the country of origin, raw materials, formula ingredients, manufacturing procedure as well

as their consumption patterns (Hou and Kruk 1998; Hou 2001). However, the noodles are prepared using wheat flour of either hard or soft wheat (*Triticum aestivum)* along with water, salt and alkaline salts. In noodle manufacturing less amount of water is required as compared to other bakery products (Miskelly 1993; Croke and Bhattacharya 1999). The characteristics of instant noodles like taste, nutrition, convenience, safety, longer shelf-life and reasonable price have made them popular worldwide. Instant noodles are also used as space and emergency food. Flour made from hard wheat *(Tritium aestivum)* is usually used as major primary ingredient (Fu 2008) and alkaline salts are added to strengthen the structure (Hou and Kruk 1998). Nevertheless, the heavy metal contamination of food product is becoming an imminent problem at present. Environmental pollution is contributing to the presence of harmful elements, such as cadmium (Cd), chromium (Cr), manganese (Mn), nickel (Ni) and lead (Pb) in food stuff including the instant noodles. The heavy metal occurrence is increased due to the enriched ecosystem components. Heavy metals are considered as toxic to living organism due to their tendency to accumulate in selected tissues (Zukowska and Biziuk 2008). The long term exposure can result reduction in neuropsychological function and inhibition of biosynthesis of heme which are caused by high level of lead in the central nervous system and blood system respectively; tubular nephritis dysfunction and slight anemia caused by cadmium in the renal system and blood system respectively (Igwe *et al.*, 2012). Therefore, the objectives of this study were to evaluate the proximate composition and heavy metal concentration of branded instant noodles available in Bangladesh.

2. MATERIALS AND METHODS

Study Area

The experimental analyses of collected samples were carried out in the phytochemistry laboratory of Bangladesh Council of Scientific and Industrial Research (BCSIR), Chattogram.

Sample Collection

A total thirty (30) branded instant noodle samples from six different brands was bought from the local market of Chattogram. These noodles are commonly sold in Bangladeshi market as instant noodles. The collected samples were directly transported to the laboratory for analysis.

Determination of Quality Parameters

The quality parameters (moisture content, ash content, crude protein, crude fat, crude fibre and carbohydrates) of collected samples were determined by using standard analytical procedures.

Determination of Heavy Metal Concentration

Atomic Absorption Spectrophotometer (200 Perkin Elmer) was used to examine the concentration (mg/kg) of heavy metals (Cd, Cr, Mn, Ni and Pb) of collected branded instant noodles samples.

Statistical analysis

Results generated in this study were expressed as mean ± standard deviation of five independent replications. The statistical significance of the generated results was obtained by subjecting the results to one-way analysis of variance (ANOVA) along with the least significant difference (LSD) test using SPSS software (SPSS 16.0). The level of significance of the mean values was assigned at $p<0.05$.

3. RESULTS AND DISCUSSIONS

The moisture content of these instant noodles ranged between 2.10 to 4.15% (Table 1). This showed that the average value of moisture obtained from BN_1 (Branded noodles 1) was significantly ($p<0.05$) higher and BN_2 (Branded noodles 2) was significantly ($p<0.05$) lower than the moisture content of other samples (Table 1). According to Bangladesh Standard and Testing Institution (BSTI), the maximum moisture content of noodles should be 10% (BSTI, 2001). From the result showed that all samples had lower moisture content than standard limits recommended for safe keeping samples. This variation might be resulted from the differences in the level of water added to noodles, extent of drying and storage temperature. High moisture content is a disadvantage for which microbial proliferation is increased and shelf life is reduced.

Meanwhile the ash content in all the samples ranged from 0.97% (BN_6) to 2.27% (BN_3) and showed a significant ($p<0.05$) variation among all the instant noodles (Table 1). This result was similar with the

study of Omeira *et al.*, (2014) who observed ash content level ranging between (0.87-2.63%) in noodles produced from blends of wheat, acha and soybean. The ash value is an empirical measurement of the mineral constituent of foodstuff component which is essential in nutrition (Oko and Ugwa 2011). The ash contents of samples are significantly affected by the variety of grain, soil condition, milling procedure and flour quality.

Result from this study indicated that the BN_2 (Branded noodles 2) had the lowest average crude protein 8.65% while the BN_3 (Branded noodles 3) had the highest average crude protein 17.30%.

There was however on significant difference in the protein content between BN_4 and BN_5 (Table 1). Baik and Lee (2003) and Wang *et al.*, (2004) reported that the protein values were between 10.5-16.5% and 10.1 to 19.9% respectively for cooked white salted noodles. The analysis showed that protein contents of all commercial brands of noodles were almost within the range reported by them. These values showed that all samples contained high levels of proteins and can be essential for the children in case of protein energy malnutrition.

Statistically there was a significant differences ($p<0.05$) within crude fat content of different samples. Sample BN_4 had significantly ($p<0.05$) higher fat content (17.24%) followed by BN_1 (17.18%), BN_6 (16.69%), BN_3 (16.44%), BN_2 (15.56%) and BN_5 (15.26%). The maximum fat content of noodles should be 2% (BSTI, 2001). All the commercial brands had higher fat content than maximum limits. Those values were consistent with Onyema *et al.*, (2014). Food sample with high fat content is more liable to spoilage than one with a lower fat content.

Based on the results, it was noticed that the crude fibre content of different noodles had increased significantly ($p<0.05$) from 6.19% (BN_6) to 11.99% (BN_4). Those values were significantly higher than that the work of Onyema *et al.*, (2014). The analysis revealed that all noodles contained high levels of crude fibre. High dietary fibre is considered as advantages because it reduces bowel problems including constipation which is basic to numerous diseases such as appendicitis, diabetes, large bowel cancer, obesity and gallstone (Moroni *et al.*, 2009; Dewettinck *et al.*, 2008).

Carbohydrate is the major macronutrients in commercial branded noodles and ranged from 54.67% (BN_3) to 62.99% (BN_2). According to Vijayakumar and Boopathy (2014), the carbohydrate contents of the noodles varied from 53.14 to 62.5%. The minor variation might be due to the varietal difference, seed quality, storage condition, method of analysis and extent of drying.

The assessment of heavy metal content in six brands of instant noodles revealed that the noodles had significantly ($p<0.05$) varying concentrations of heavy metals (Table 2). Cd in all examined samples spanned between 0.0040 mg/kg (BN_2) to 0.0730 mg/kg (BN_5). No significant difference ($p>0.05$) was observed in Cd content for BN_1, BN_3 and BN_4 (Table 2). Onyema *et al.*, (2014) found Cd at levels above the limit of detection in different branded noodles. Interestingly Cd was not detected in samples of the six noodle brands reported by Charles *et al.*, (2017). The WHO standard for Cd is 0.003 mg/kg while the FDA standard is 0.005 mg/kg (WHO, 2003; Mcintyre, 2003). According to results, all the samples were exceeding the permissible level given by WHO. These results are of concern as Cd is highly toxic and is regarded as the most serious contaminant. Cd may accumulate in human food chain magnification and may induce kidney dysfunction, skeletal damage, cancer, tubular growth, diarrhea and vomiting (Martin and Griswold, 2009).

As for the Cr content, it varied significantly ($p<0.05$) from 0.0678 mg/kg (BN_5) to 0.1204 mg/kg (BN_6), all values above the WHO standard for Cr in food (WHO 2003). The average values posted for Cr in this study were little higher than the posted corresponding values for Cr (0.063-0.118) mg/kg in instant noodles samples (Onyema *et al.*, 2014). According to Ikeda *et al.*, (2000), Cr is a non-essential metals causing adverse health effect such as respiratory cancer and ulcer at very low concentration.

Likewise the Mn contents in samples ranged from 0.0960 mg/kg (BN_6) to 0.1702 mg/kg (BN_2). The differences were significant ($p<0.05$) among all the samples except for BN_1 and BN_2 (Table 2). Sources of this trace metal might be water, salt and other additives usually added to noodles during processing. The concentrations of Mn in this study were lower than the

Table-1: Quality Parameters of the Selected Branded Instant Noodles Samples

Sample ID	Moisture Content (%)	Ash Content (%)	Crude Protein Content (%)	Crude Fat Content (%)	Crude Fibre Content (%)	Carbohydrate Content (%)
BN_1	4.51 ± 0.3^{a}	1.13 ± 0.07^{a}	9.38 ± 0.39^{a}	17.18 ± 0.32^{a}	8.09 ± 0.91^{a}	59.7 ± 1.28^{a}
BN_2	2.35 ± 0.3^{b}	1.22 ± 0.06^{b}	8.65 ± 0.03^{b}	15.56 ± 0.50^{b}	9.23 ± 0.51^{b}	62.99 ± 0.97^{b}
BN_3	2.1 ± 0.03^{c}	2.27 ± 0.02^{c}	17.3 ± 0.07^{c}	16.44 ± 0.09^{c}	7.22 ± 0.33^{c}	54.67 ± 0.26^{c}
BN_4	3.17 ± 0.7^{d}	1.02 ± 0.02^{d}	10.28 ± 0.04^{d}	17.24 ± 0.11^{d}	11.99 ± 0.79^{d}	56.31 ± 0.75^{d}
BN_5	3.07 ± 0.1^{d}	1.28 ± 0.05^{ae}	10.26 ± 0.18^{d}	15.26 ± 0.04^{d}	8.01 ± 0.30^{a}	62.11 ± 0.34^{b}
BN_6	4.13 ± 0.13^{e}	0.97 ± 0.05^{d}	9.81 ± 0.12^{e}	16.69 ± 0.18^{c}	6.19 ± 0.08^{e}	62.22 ± 0.29^{b}

NOTE: BN_1 = Branded noodles 1, BN_2 = Branded noodles 2, BN_3 = Branded noodles 3, BN_4 = Branded noodles 4, BN_5 = Branded noodles 5, BN_6 = branded noodles 6, Values are mean ± standard deviation (n=5). Mean values marked with different letters in a same column are significantly different by the LSD test ($p<0.05$). Mean values marked with same letters in the same column are not significantly different ($p>0.05$).

Table-2: Heavy Metals Concentration of the Selected Branded Instant Noodles.

Sample ID	Cadmium (mg/Kg)	Chromium (mg/Kg)	Manganese (mg/Kg)	Nickel (mg/Kg)	Lead (mg/Kg)
BN_1	0.0074 ± 0.0015^{a}	0.0868 ± 0.0052^{a}	0.1276 ± 0.0162^{a}	0.0132 ± 0.0025^{a}	0.0252 ± 0.0026^{a}
BN_2	0.0040 ± 0.0016^{b}	0.0926 ± 0.0036^{ab}	0.1702 ± 0.0026^{b}	0.0342 ± 0.0033^{b}	0.0696 ± 0.0018^{b}
BN_3	0.0072 ± 0.0013^{a}	0.0874 ± 0.0078^{a}	0.1244 ± 0.0045^{c}	0.0162 ± 0.0030^{a}	0.0284 ± 0.0023^{c}
BN_4	0.0044 ± 0.0015^{b}	0.0810 ± 0.0047^{ac}	0.1538 ± 0.0527^{b}	0.0142 ± 0.0022^{a}	0.0336 ± 0.0026^{d}
BN_5	0.0730 ± 0.0040^{c}	0.0678 ± 0.0034^{d}	0.1344 ± 0.0025^{a}	0.0214 ± 0.0004^{c}	0.0205 ± 0.0011^{e}
BN_6	0.0072 ± 0.0013^{a}	0.1204 ± 0.0034^{e}	0.0960 ± 0.0029^{c}	0.0074 ± 0.0011^{d}	0.1144 ± 0.0029^{f}
WHO	0.003	0.050	NA	1.0	0.025

NOTE: BN_1 = Branded noodles 1, BN_2 = Branded noodles 2, BN_3 = Branded noodles 3, BN_4 = Branded noodles 4, BN_5 = Branded noodles 5, and BN_6 = Branded noodles 6, WHO= world health organization. NA= not available.

Values are Mean ± Standard deviation (five determinations). Mean followed by different superscript in each column are significantly different by the LSD test ($p<0.05$).

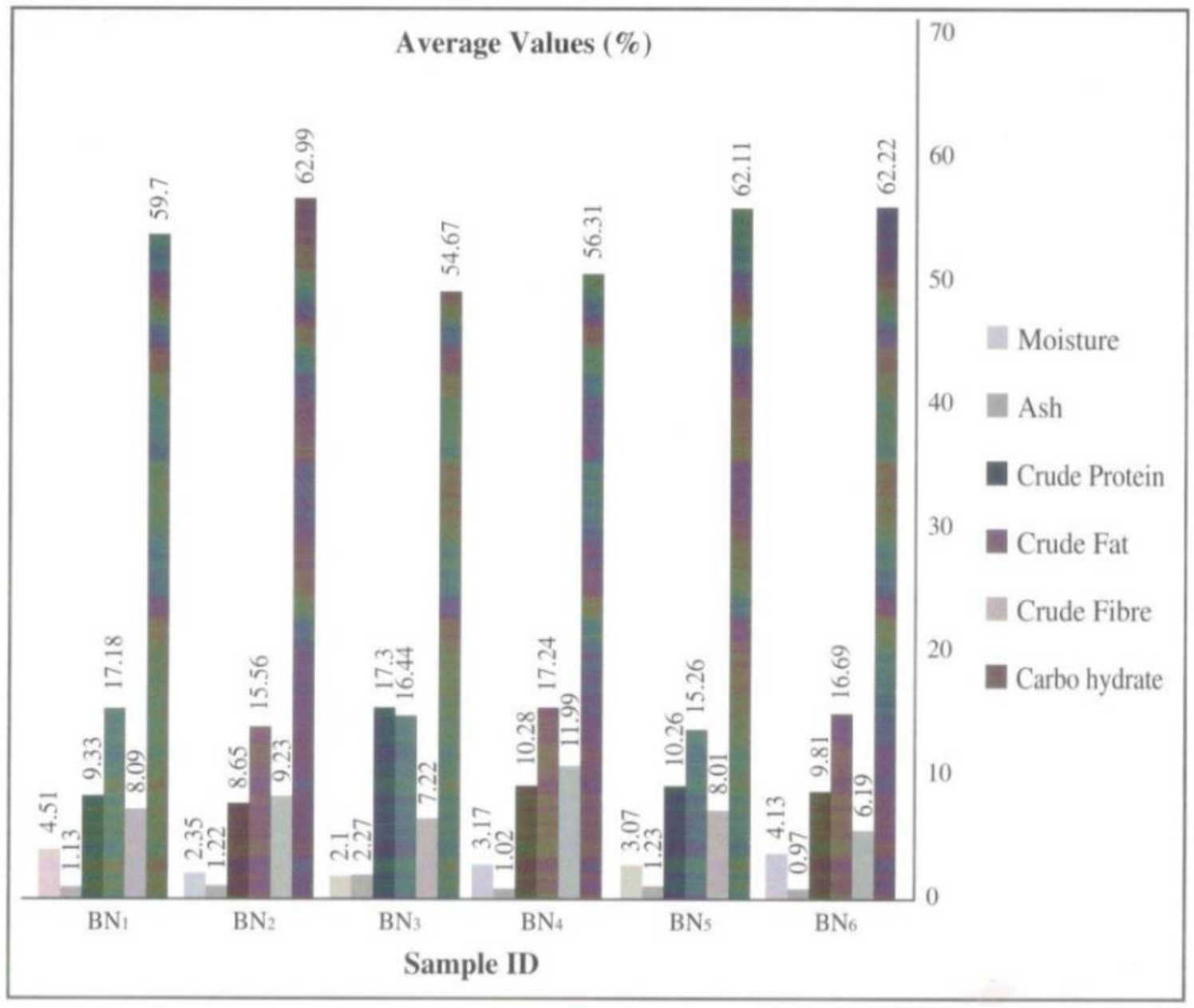
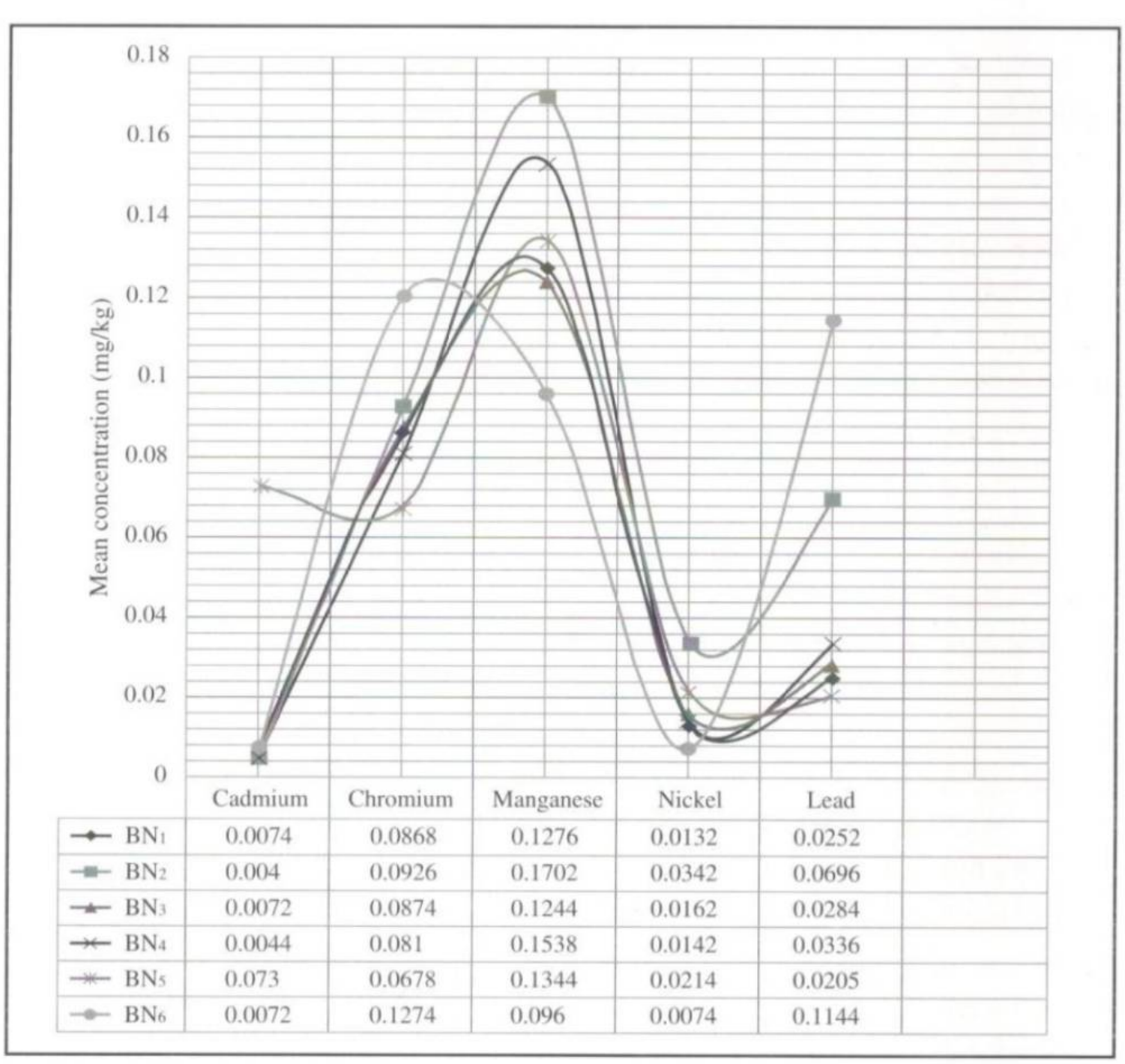


Figure 1: Graphical Representation of Quality Parameters of Instant Noodles



	Cadmium	Chromium	Manganese	Nickel	Lead
BN1	0.0074	0.0868	0.1276	0.0132	0.0252
BN2	0.004	0.0926	0.1702	0.0342	0.0696
BN3	0.0072	0.0874	0.1244	0.0162	0.0284
BN4	0.0044	0.081	0.1538	0.0142	0.0336
BN5	0.073	0.0678	0.1344	0.0214	0.0205
BN6	0.0072	0.1274	0.096	0.0074	0.1144

Figure 2: Representation of Heavy Metal Contamination of Instant Noodles

permissible limit of Mn (5.5 mg/kg) in food according to Makimilua and Afua (2013). The national research council of Canada has recommended safe and adequate daily intake levels of Mn that ranged from 0.3-1 mg/day for children up to 1 year, 1-2 mg/day for children up to age 10 and 2-5 mg for children up to 10 and older (Institute of Medicine, 2001).

Meanwhile the highest value of Ni found in BN_2 (0.0342 mg/kg), the lowest amount of Ni found in BN_6 (0.0074 mg/kg) (Table 2). Significant differences ($p<0.05$) were observed between different samples. However the Ni concentration was significantly lower than (0.012 to 0.345) mg/kg reported by Charles *et al.*, (2017) on the instant noodles in Nigerian market. The permissible limit of Ni is 1.0 mg/kg (WHO 2011; BSTI 2001). According to Food and Nutrition Board, the maximum permissible limit of Ni is 4 mg/kg (Ambadekar *et al.*, 2012). Therefore all the samples were within permissible limit. The excessive content of this metal in food is associated with etiology of a number of diseases such as dramatis, cancer, thyroid problem and heart disease (Duffus, 2002).

As for Pb content, it varied from 0.0205 mg/kg (BN_5) to 0.1144 mg/kg (BN_6). Similar work on instant noodles by Satsananan (2017) showed Pb contents were within the WHO set limit. The permissible limit of Pb in food is 0.025 mg/kg (WHO, 2003). All the noodle brands except BN_5 in this study were above the permissible limit. This toxic metal primarily affects the peripheral and central nervous systems, renal functions, blood cells, metabolism of vitamin D. It is also responsible for hypertension, reproductive toxicity and neurological disorders (Duffus, 2002). It has been reported that raw materials, contaminated water, food processing equipment, containers have recognizes as a source of Pb in food (Khaniki *et al.*, 2005).

4. CONCLUSION

This study finding showed that Bangladeshi commercial instant noodles are a good source of carbohydrate, protein and crude fibre which benefit human health but the fat content of these noodles should be reduced. The relatively low fat content in noodles is desirable for health conscious consumers. Results of heavy metal analysis showed that the levels of Mn and Ni are generally within safe limits while the Cd, Cr and Pb levels were little bit above the permissible limits. There is need for relevant regulatory bodies in Bangladesh to establish strict production and carry out regular monitoring of these noodles producers to prevent excessive build up of heavy metals in food chain.

5. ACKNOWLEDGEMENT

Authors would like to thank the staff and laboratory workers of the Bangladesh Council of Scientific and Industrial Research (BCSIR), Chattogram, Bangladesh for their efforts during this experimental study.

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