Defence Life Science Journal, Vol. 4, No. 2, April 2019, pp. 91-95, DOI : 10.14429/dlsj.4.13307

Physico - Chemical and Microbial Analysis of Different Sources of Water collected from Indora, Himachal Pradesh, India

Shivali Bhardwaj and Arup Giri*

Department of Life Sciences, Arni University, Kathgarh - 176 401, India.
**E-mail: arupsatadal@gmail.com*

ABSTRACT

Life could not be imagining without the presence of water on this earth. An ecosystem is very dependent on the quality of water. Regular water quality monitoring is very essential of a region. In the study area, no study has been yet done on the quality of drinking water and productivity level of Beas river near Arni University, Himachal Pradesh, India. The main aim of this study was to determine the water quality of three different sources of water like hand pump water, tap water, and Beas river water. For this, we have collected total twenty-six samples in the month of May 2018 and analysed for pH, TDS, EC, DO, alkalinity, phenolphthalein alkalinity, total hardness, calcium hardness, chloride, sulfate, phosphate, nitrate, carbonate, bicarbonate, *E. coli*, and productivity level by standard methods. The entire analysed parameters showed the lower level than the permissible guideline of the WHO except for the presence of *E. coli* and higher level of alkalinity. The productivity level of Beas river was indicating that trophic index belonged to the ultra-oligotrophic. From the findings, it might be concluded that hand pump water, tap water, and Beas river water was drinkable except the presence of *E. coli* and higher level of alkalinity in tap water and river water. However, in the case of the productivity level of Beas river was indicating the very low accumulation of dissolved nutrient salts, and a lower rate of algae growth as the productivity level belonged to the ultra-oligotrophic. Further extensive study on the water minerals and heavy metals level in all the water sources are required in this study area.

Keywords: Beas river water; *E. coli*; Hand pump; Physico-chemical; Tap water; Water quality

1. INTRODUCTION

Life begins on this Earth and life dependents on the water in such a way that water called as 'life'. All the life on the Earth is centerlines on the quality of the water. Water quality reveals on the physical, chemical, and microbial properties. At the dawn of the mankind, water quality was fine but due to the changing scenario in the present decade, water quality is going to deteriorate. Changing pattern is everywhere like climate, precipitation, cultivation, groundwater abstraction, industrialisation and increase in the global population[1].

Due to the alteration of the water quality, mankind throughout the globe is facing a severe problem. One-sixth of the people around the globe are not getting clean and safe water. In India, about seventy-six million people are not getting the drinkable water and this statistic followed by the other country like China (sixty-three million), Nigeria (fifty-eight million) and Ethiopia (forty-two million) amongst others[2]. According to WHO, water born disease is getting higher frequency in the developing world. Statistics of WHO was indicating that about 1.1 billion people were forced to drink the unsafe water. Contaminated water globally caused death around two million and most of the child below the age of five years are affected[3].

Received : 11 July 2018, Revised : 23 January 2019
Accepted : 18 February 2019, Online published : 11 April 2019

Poor water quality also affects the livestock health and production level. Most of the farmers are unaware of the safe water quality for the dairy cows. Contaminated water greatly affects the food and water intake. Ultimately, this affects the metabolic rate of the animal. For example, high sulfate levels in water significantly decreased water intake in cattle[4]. Changes in the TDS level also caused the drastic changes in the animal body due to decrease feed intake. Therefore, changes in the physical properties of drinking water are not only affecting mankind but also affects on the performance of the livestock population[5]. Chemical contamination in water occurs mainly due to the industrial wastage, domestic wastage, and finally anthropogenic activity[6]. *E. coli*, a fecal coliform indicate the microbiological contamination in the drinking water[7]. So, physicochemical, and microbiological parameters are the main parameters to assess the water quality. Study of these parameters will help in picturising the water quality status in any region.

Therefore, in the study area, no study has been yet done on the water quality of hand pump, tap water, and Beas river water in terms of physicochemical, and microbiological parameters. Hence, we have performed this study with the main aim to determine the water quality of three different sources.

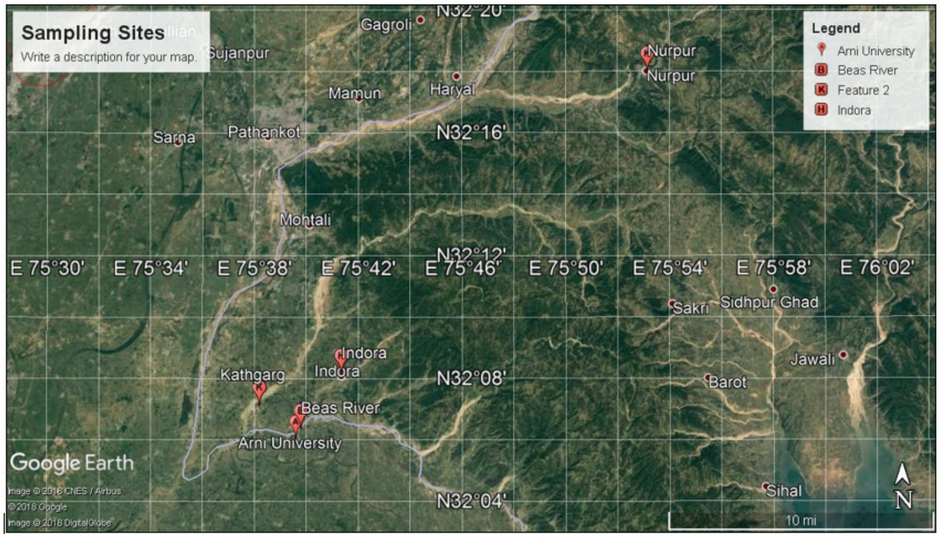

Figure 1. Water sampling map made by Google 3D earth software.

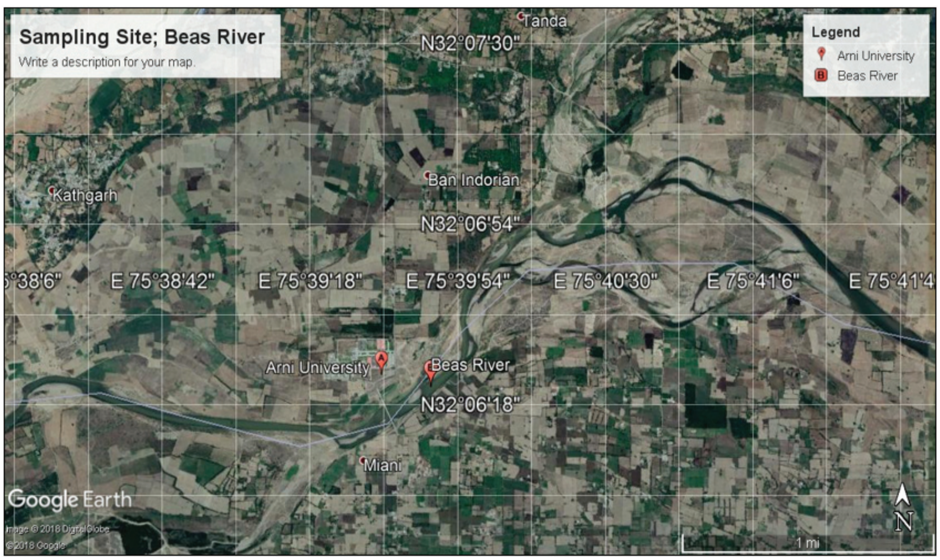

Figure 2. Water sampling from Beas river and the map made by Google 3D earth software.

2. MATERIALS AND METHODS

2.1 Experimental Design

Twelve water samples of the hand pump and twelve water samples of tap water were collected for analysis. The sites from where hand pump and tap water samples were collected, presented in Fig. 1. The range of the Hand pump depth was 40 ft to 500 ft and range of the age was 18 to 26 yrs. The source of tap water was stored water in the house which was abstracted from the underground by electric pump. However, two water samples were collected from the Beas river flowing near about the Arni University (Fig. 2). Samples were collected from all sources between 9.00 hrs to 10.00 hrs. All the sampling sites were located near the village and farmland. The sites were frequently used for the water consumption and domestic activity. The water samples were collected at a depth of 10 cm of the Beas river and placed into 500 mL polypropylene bottles. Samples were stored in the laboratory at the temperature of 4 °C for subsequent chemical analysis[8]. The chemical measurements were performed in the laboratory within 24 hrs after the collection of the water samples. GPS readings were taken by Garmin GPS 72H to identify the sampling locations.

2.2 Study Area

Indora, the study area located in the western most part of the state of Himachal Pradesh, North-eastern part of India (Fig. 2). It is the part of a metropolitan area of Pathankot, located on the shores of Beas river, in a very affluent area with very fertile soils. The mean latitude of Indora is 32.134632N and the longitude is 75.689171E. The elevation is 294 meters in height that are equal to 965 feet.

2.3 Collection of Water Samples for Physico-Chemical Analysis

Samples for physicochemical analysis were collected and after collection, these samples were kept in refrigerator until the samples were used in the laboratory at the temperature of 0–4 °C for subsequent chemical analysis[8]. After collection, all twenty-four samples were fixed with 1 mL toluene after taking the readings of pH, EC, and TDS[8]. The Beas river water which is collected directly added with manganous sulfate followed by potassium iodide and then concentrated sulfuric acid is added to measure the productivity.

2.4 Analysis of Water Samples

Analysis of water was done for the parameters like pH, TDS, EC, dissolved oxygen, total alkalinity, phenolphthalein alkalinity, total hardness, calcium hardness, chloride, nitrates, sulfates, phosphate, carbonates, bicarbonates, and *E. coli* to assess the water quality. The productivity of Beas river water was measured.

In-situ parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS) by using portable meter pH meter, EC meter, and TDS meter, respectively[9]. All the instruments were calibrated before analysis of the sample. Dissolved oxygen (DO) was analysed by the Winkler method[10]. Major anions such as carbonate (CO_3), and bicarbonate (HCO_3^-) were analysed by titrimetric method[8]. Total hardness and calcium hardness was measured by the titrimetric method[13]. Level of chloride (Cl^-) was detected by Mohr's Method[11]. Alkalinity and phenolphthalein alkalinity was measured by titration methods[11]. Among anions, sulfate (SO_4^{2-}), nitrate (NO_3^-), and orthophosphate (PO_4^{3-}) were analysed through the protocol as described in American Public Health Association[11].

Table 1. Descriptive statistics of the physico-chemical and microbiological levels in different sources of water

Water source	pH	TDS (mg/L)	EC (µS/cm)	DO (mg/L)	Alkalinity (mg/L)	Phe Alkalinity (mg/L)	ToHard (mg/L)	CaHard (mg/L)
Tap water	7.87 ± 0.26	18.33 ± 3.87	2.83 ± 0.83	6.63 ± 1.26	285.17 ± 99.64	ND	0.43 ± 0.09	ND
Hand pump water	7.42 ± 0.28	36.58 ± 21.30	5.42 ± 3.23	5.07 ± 1.22	ND	ND	1.57 ± 0.60	ND
River water	8.10 ± 0.02	15.50 ± 0.71	2.00 ± 0.00	9.60 ± 1.70	186.00 ± 14.14	ND	ND	ND

Water source	Chloride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	Phosphate (mg/L)	Carbonate (mg/L)	Bicarbonate (mg/L)	*E. coli* (CFU/ml)	Productivity (mgc/m³/hr)
Tap water	34.55 ± 23.07	ND	0.23 ± 0.09	ND	68.75 ± 0.10	ND	23.361 ± 3.93	NA
Hand pump water	97.86 ± 87.10	ND	1.38 ± 0.24	ND	94.33 ± 1.50	ND	104.167 ± 44.23	NA
River water	43.31 ± 3.01	ND	1.77 ± 0.37	ND	63.50 ± 7.21	ND	213.17 ± 49.67	15.63 ± 0.55

Note: Values in Average ± SD. ND - Not detected, NA - Not applicable, EC - Electrical conductivity, TDS - Total dissolved solids, DO - Dissolved oxygen, Chl - Chloride, Alk - Alkalinity, Phe Alkalinity - Phenolpthalein alkalinity, CaHard - Calcium hardness, ToHard - Total hardness, Sul - Sulfate, Phos - Phosphate, Carbo - Carbonate, Bicarbo - Bicarbonate, Nitr - Nitrate, E. coli - *Escherichia coli*

For the microbiological analysis of water, *E. coli* bacteria were selected. *E. coli* in water samples were identified by the pour plate method as described in the Medical Laboratory Manual for Tropical Countries[12]. 1 mL of each of the water samples was aliquoted into sterile MacConkey agar plates and uniformly spread over the entire surface of the agar and incubated at 44°C for 48 hrs. The total numbers of formed colonies by *E. coli* were counted and the mean values of three replicates were calculated[12].

The primary productivity of the Beas river water was determined by 'light and dark bottle method'[13].

3. RESULTS AND DISCUSSION

All the water samples were analysed for pH, TDS, EC, DO, alkalinity, phenolphthalein alkalinity, total hardness, calcium hardness, chloride, sulfate, phosphate, nitrate, carbonate, bicarbonate, *E. coli*, Productivity. Among all these parameters, phenolphthalein alkalinity, calcium hardness, phosphate, nitrate, bicarbonate was in not detected level. Total hardness in river water was also not detected (Table 1). It was found that pH of the river water (8.10 ± 0.02) was slightly alkaline in nature than the tap water (7.87 ± 0.26) and hand pump water (7.42 ± 0.28). TDS level and electrical conductivity was higher in hand pump (36.58 ± 21.30 mg/L, 5.42 ± 3.23 mg/L) water than the tap water (18.33 ± 3.87 mg/L, 2.83 ± 0.83 mg/L) and river water (15.50 ± 0.71 mg/L, 2.00 ± 0.00 mg/L). In case of dissolved oxygen, it was higher in the river water (9.60 ± 1.70 mg/L) than the tap water (6.63 ± 1.26 mg/L) and hand pump water (5.07 ± 1.22 mg/L). Tap water (285.17 ± 99.64 mg/L) showed a higher level of alkalinity than the river water (186.00 ± 14.14 mg/L). Insignificant levels of total hardness were found in tap water (0.43 ± 0.09 mg/L) and hand pump water (1.57 ± 0.60 mg/L). Chloride and carbonate levels were higher in the hand pump water (97.86 ± 87.10 mg/L; 94.33 ± 1.50 mg/L) than the tap water (34.55 ± 23.07 mg/L; 68.75 ± 0.10 mg/L) and river water (43.31 ± 3.01 mg/L; 63.50 ± 7.21 mg/L). Sulfate level was very insignificant in all the sources (0.23 ± 0.09 mg/L; 1.38 ± 0.24 mg/L; 1.77 ± 0.37 mg/L). It was found that Beas river water (213.17 ± 49.67 CFU/mL) was highly contaminated with *E. coli* than the tap water (23.361 ± 3.93 CFU/mL) and hand pump water (104.167 ± 44.23 CFU/mL) (Table 1). As the productivity value of the Beas river was 15.63 ± 0.55 mgc/m³/hr, so it belongs to the ultra-oligotrophic level (Table 1).

All the parameters showed the lower level than the permissible guideline of WHO except *E. coli*. The permissible limit of drinking water by WHO and BIS[14-15] are presented in Table 2.

Weathering, efficient delivery, and accelerated dissolution of calcium carbonate caused the higher level of alkalinity and calcium level in water sources[16-17]. In the study area, it was found that hardness and alkalinity were very low. Water hardness mainly depends upon the level of calcium and magnesium level. It was reported that, throughout Himachal Pradesh, it was found that the soil is deficient in essential nutrients like calcium, magnesium, phosphorus, sulfur[18]. So this is the most probable reason for the lower level of electrical conductivity, TDS, chloride, nitrate, sulfate, phosphate, carbonate, bicarbonate level in all the sources of water. Presence of moderate level of chloride concentrations in all the water sources might be due to the wastewater leakage, runoff of lawn fertilisers, and spills or discharges of varied substances containing chlorides[16-17].

The level of *E. coli* was mostly higher in Beas river water followed by hand pump water and tap water. This scenario might be due to the open sources of wastage from the civil populace and by the presence of free moving animals near about the river[16]. Hand pump contaminated might be due to the location of hand pump near about the sanitary system or unprotected area near the hand pump[16-19].

Productivity attributes on the biological population in any aquatic ecosystem. Higher the productivity level is helpful for the healthy aquatic population[20-21]. In our study, the productivity

Table 2. Normal levels of water physico-chemical and microbial parameters of drinking water by WHO and BIS.

Parameters	WHO, 1998[14]		BIS, 1991[15]
	Highest desirable	Maximum permissible	
pH at 20 ^{O}C	7.0-8.9	6.5-9.5	6.5-8.5
Electrical conductivity	900 (µs/cm^4)	1200 (µs/cm^4)	-
Total dissolved solids	-	1000 mg/L	1000 mg/L
Dissolved oxygen	-	-	5 mg/L
Total hardness	100 mg/L	500 mg/L	200 mg/L
Total alkalinity	100 mg/L	100 mg/L	600 mg/L
Phenolphthalein alkalinity	100 mg/L	100 mg/L	-
Chloride	200 mg/L	250 mg/L	1000 mg/L
Nitrate	10 mg/L	50 mg/L	-
Sulfate	250 mg/L	500 mg/L	200 mg/L
Phosphate	0.5 mg/L	1.0 mg/L	-
E. coli	0	0	0

level of Beas river water was 15.63 ± 0.55 mgc/m^3/hr. One of our earlier studies indicated that the Beas river belongs to the ultraoligotrophic level[22].

In conclusion, this is new information on different water quality parameters viz. physical, chemical, and microbiological of the tap water, hand pump water, and Beas river water in the Tehsil Indora of Himachal Pradesh. Results showed that the alkalinity level was higher in the tap water and river water samples. *E. coli* levels were higher in all the sources than the prescribed limits of the WHO. River water showed a higher level of *E. coli*. All other parameters showed the lower limit which was prescribed by the WHO (1998). Productivity status of the river showed the ultraoligotrophic level. These findings indicated that river water and tap water has the low quality for the drinking purpose as the higher level of alkalinity and *E. coli* level. A further extensive study on the water minerals and heavy metals level of all the water sources has been required.

CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

1. Venkatesharaju, K.; Ravikumar, P.; Somashekar, R.K. & Prakas, K.L. Physico-chemical and bacteriological investigation on the river Cauvery of Kollegal Stretch in Karnataka. *J. Sci. Eng. Technol.,* 2010, **6**(1), 50-59. doi: 10.3126/kuset.v6i1.3310.
2. Water: At what cost? The state of the world's water 2016. A report by WaterAid. http://www.cwc.nic.in/main/webpages/statistics.html (Accessed on 28 March 2018)
3. World Health Organisation. Emerging issues in water and infectious disease. World Health Organisation (WHO), Geneva, Switzerland, 2003. https://goo.gl/dyQWRQ (Accessed on 28 March 2018)
4. Grout, A.S.; Veira, D.M.; Weary, D.M.; von Keyserlingk, M.A.G. & Fraser, D. Differential effects of sodium and magnesium sulfate on water consumption by beef cattle. *J. Animal Sci.*, 2006, **84**, 1252–58. doi: 10.2527/2006.8451252x.
5. Loneragan, G.H.; Wagner, J.J.; Gould, D.H.; Garry, F.B. & Thoren, M.A. Effects of water sulfate concentration on performance, water intake, and carcass characteristics of feedlot steers. *J. Animal Sci.*, 2001, **79**, 2941-48. doi: 10.2527/2001.79122941x.
6. Jaishankar, M.; Tseten, T.; Anbalagan, N.; Mathew, B.B. & Beeregowda, K.N. Toxicity, mechanism and health effects of some heavy metals. *Interdiscip. Toxicol.,* 2014, **7**, 60–72. doi: 10.2478/intox-2014-0009.
7. Edberg, S.C.; Rice, E.W.; Karlin, R.J. & Allen, M.J. *Escherichia coli*: the best biological drinking water indicator for public health protection. *J. Appl. Microbiol.,* 2000, **88**, 106S–16S. doi: 10.1111/j.1365-2672.2000.tb05338.x.
8. Singh, D.; Chhonkar, P.K. & Dwivedi, B.S. Manual on Soil, Plant and Water Analysis. Westville publishing house, New Delhi, 2005. https://goo.gl/rWwnkU (Accessed on 9 January 2018)
9. American Public Health Association (APHA). Standard methods for the examination of water and waste water. American Public Health Association, USA, 18th ed., Washington DC, USA, 1992. https://law.resource.org/pub/us/cfr/ibr/002/apha.method.9221.1992.pdf(Accessed on 9 January 2018)
10. Manivaskam, A. Analysis of water and wastewater. Pragathi Prakasan Publications, 1997.
11. American Public Health Association (APHA). Standard methods for the examination of water and waste water. American Public Health Association, USA, 20th ed., Washington DC, 2012. https://store.awwa.org/store/productdetail.aspx?productid=28493774 (Accessed on 9 January 2018)
12. Cheesbrough, M. Health and safety in district laboratories. District Laboratory practice in tropical countries, 50–95. doi: 10.1017/cbo9780511581304.005.
13. Garder, T.G. & Green, H.H. Investigation of the production of plankton in the Osio Ford. Rapp. *Process- Reunions Counc. Pernt. Int. Explor.,* 1927, **42**, 1-48.
14. WHO. Guidelines for drinking water quality. Health criteria and other supporting information. Geneva, Switzerland, 1998. https://goo.gl/CBEwm3. (Accessed on 28 March 2018)
15. Indian standard for drinking water. Bureau of Indian Standard, New Delhi, India, 1991, 1-9. http://cgwb.gov.in/Documents/WQ-standards.pdf (Accessed on 7 February 2018)

16. Giri, A.; Bharti, V.K.; Kalia, S.; Kumar, K.; Raj, T. & Kumar, B. Utility of multivariate statistical analysis to identify factors contributing groundwater quality in high altitude region of Leh-Ladakh, India. *Asian J. Water Environ. Pollut.*, 2017, **14**, 61–75. doi: 10.3233/ajw-170037.
17. Bharti, V.K.; Giri, A. & Kumar, K. Evaluation of physico-chemical parameters and minerals status of different water sources at high altitude. *Peertechz J. Environ. Sci. Toxicol.*, 2017, **2**, 10-18. doi: 10.17352/pjest.000007.
18. Kumari, S. Nutritional status of citrus (Kinnow) growing soils and plants of district Kangra of Himachal Pradesh. Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni Solan - 173 230 (HP), India, 2015. PhD Thesis. http://krishikosh.egranth.ac.in/bitstream/1/86703/1/PDF%20M.Sc.%20Thesis%20Sweta%20Kumari%20%20(2015).pdf
19. Charan, G. Studies on certain essential minerals status and heavy metals presents in soil, plant, water and animal at high altitude cold arid environment. JAYPEE University of Information Technology, Waknaghat, Solan, India, 2013. PhD Thesis. https://goo.gl/v7xkQ5 (Accessed on 17 January 2018)
20. Bishnoi, R.K.; Sharma, B.K.; Durve, V.S. & Sharma, L.L. Primary Productivity in relation to planktonic biodiversity in a stretch of Gang canal (Rajasthan). *Univ. J. Environ. Res. Technol.,* 2013, **3**, 266-72.
21. Mohanty, S.S.; Pramanik, D.S. & Dash, B.P. Primary productivity of Bay of Bengal at Chandipur in Odisha, India. *Int. J. Sci. Res. Public.,* 2014, **4**, 1-6.
22. Sharma, P. & Giri, A. Productivity evaluation of lotic and lentic water body in Himachal Pradesh, India. *MOJ Eco. Environ. Sci.,* 2018, **3**(5), 311–17. doi: 10.15406/mojes.2018.03.00105.

ACKNOWLEDGEMENTS

The Authors are thankful to Dr Rajesh Kumar, Head of the Division and Indu Kumari, Research Associate, Life Science Department, Arni University for providing the lab facility. We are also thankful to Ajay, Komal, Neha Manhas, Rimpi, Shalini, Shweta, Sonali, and Sunny Kumar, students of MSc Zoology, Second Semester, Life Science Department, Arni University for their technical assistance at the time of sample collection.

CONTRIBUTORS

Ms Shivali Bhardwaj completed her MSc (Zoology) from Department of Life Science, Arni University, Kathgarh, Himachal Pradesh.
In this study author has done whole sample collection, analysis and manuscript preparation.

Dr Arup Giri has obtained his PhD in Life Science, and is currently working as Assistant Professor in Department of Life Science at Arni University, Kathgarh, Himachal Pradesh. He has published around 27 research articles in journals. His area of research is nutrition and toxicology.
Under the supervision of the author, whole work has been done.