Russian Journal of Biological Research

Has been issued since 2014.
E-ISSN 2413-7413
2018. 5(1). Issued 1 times a year

Journal is indexed by: **Cross Ref** (USA), **MIAR** (Spain), **Open Academic Journals Index** (USA).

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Founder and Editor: Academic Publishing House Researcher s.r.o.

Release date 25.03.18.
Format 21 × 29,7/4.

Headset Georgia.

Order № B-10.

Russian Journal of Biological Research

2018

Is. 1

C O N T E N T S

Articles and Statements

Published in the Slovak Republic
Russian Journal of Biological Research
Has been issued since 2014.
E-ISSN: 2413-7413
2018, 5(1): 3-5

DOI: 10.13187/ejbr.2018.1.3
www.ejournal23.com

Articles and Statements

Evaluation of Chemical Properties and Mineral Composition of Powdered and Dried Leaves of Baobab in Bauchi Metropolis

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Abstract

The evaluation of some chemical properties and mineral composition (proximate chemical analysis) of Baobab leaves (*Adansonia digita*) collected from Muda Lawal market were analyzed at the soil science laboratory of Abubakar Tafawa Balewa University, Bauchi using flame photometric and atomic absorption spectrophotometry. The results showed that the concentration of crude protein ranged from 1.44-1.63 with CV of 5.7 % and that of crude fibre range from 0.81-0.97 and CV 12.7 %. The chemical composition showed that ash ranged from 1.48-1.65 with CV of 7.7; Ca from 2.51-2.63 with CV 3.91 %; K from 0.71-0.19 with CV of 7.86 % and Na from 007-0.08 with CV 9.42 %. Based on the results obtained there were no significance (p= 0.05) difference between the powdered and dried leaves, since all the parameters observed had coefficient of variation less than 15 %. Therefore, people can consume any of the two forms of baobab leaves.

Keywords: coefficient of variation, Baobab.

1. Introduction

Baobab (Adanso*nia digituta*) belongs to the family Bambacaceae. It refers to a group of trees that are grown in tropical and sub-tropical regions of the hemisphere especially, in the Madagascar. It is probably the best know tree in Africa (Vimala, Shoba, 2014). Its thick, grey, fibrous trunk reaching in some instances over 25cm and the large spreading crown seasonally devoid of foliage, are instantly recognizable. It is sometimes called upside down tree because of its unusual, root like branch formations. It is extremely long lived, with some species believed to be as old as 3,000 years (Ibrahim, 2015).

Although the extremely high moisture content of wood renders it unusable as a timber, thus making it an excellent fiber material employed in basket, rug and rope making and has been used variously to make fishing nets, animal snares, sacking and even strings for musical instruments (De Smedt et al., 2012). The tree is best known for its high vitamin c content,/ranging 300ms/100g nearly 6 times higher than that of an orange, 20g at an average baobab fruit could provide the daily vitamin c requirement for human (Bale et al., 2013). The pulp also has value of carbohydrate, calcium, potassium, thiamine and nicotinic acid, with appreciable quantities of tartanic acid and

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potassium. The seed cakes, as well as the shells form the fruit, are a useful to livestock feed, being high in protein, calcium, vitamin B and C (De Smedt et al., 2012; Fagbohun et al., 2012).

Baobab comprises eight species with a large spectacular, nocturnal flowers, African baobab has long been known to be a bat-pollinated to be species in section brevitubae both endermic to Madagascar are pollinated by nocturnal mammals (fruits bats and lemurs) in contrast. The five species in section longitubae four endemic to the Madagascar and one to Australia are pollinated by long-tongue, hawk moths. The flowers and fruit hang from the stem which is long-tongue, hawk moths.The flowers and fruit hang from the stem which is long and ropy. The fruit with a hard woody shell covered in yellowish green velvety hair are again easily identified inside the shell the fruit containing a number of seeds, embedded in a whitish, powdery pulp and nutrients the pulp makes a tasty food after soaking in water or milk to make a refreshing beverage(Walker, 2014).

The baobab trees have large whitish flowers which open at night. The fruit which grows up to a foot long, contain tartanic acid and vitamin ca and can neither be sucked or soaked in water to make a refreshing drink (Vimala, Shoba, 2014). Fresh baobab leaves provide an edible vegetable similar to spinach which is also used medicinally to treat kidney and bladder disease, asthma, insect bites and several other maladies. The tasty and nutrients fruits and seed of several species are sought after, while pollen from the African and austrilian baobab is mixed with water glue (Ibrahim, et al., 2012; Azeh et al.,2014).

Boabab are thus plant species with a high potential in arid and semi-arid areas in the developing world. Despite the high potential, little formal research has been carried out to access their food value, potential for genetic improvement or responses to cropping and management techniques, nor are there any data available on marketability of their products.

This research therefore is intended to enable the people in the study area know the proximate and chemical composition of baobab leaves. And by extension this research would enable us understand the potential of baobab plant.

2. Materials and methods

Collection and Preparation of Leaves

The leaves of baobab were purchased from four (4) different retailers in Bauchi metropolis main market the powdered and dried leaves. The leaves were identified by two agronomist, Mallam Sanusi Adamu and Mallam Ahmad Bununu both of the Department of Agricultural Technology, College of Agriculture, Bauchi. The dried leaves were then transported to the laboratory in Abubakar Tafawa Balewa University (A.T.B.U) Bauchi and milled into powder using hammer miller machine. After milling the powder was then stored for further laboratory analysis.

Proximate Analysis

Proximate analysis of the powdered and the dried leaves were carried out to determine the crude protein, crude fibre, either extract using standard procedures. For crude protein total Nitrogen was determined by micro kjeldhal method of Uscar (1976); Ash was determined by method described by AOAC (1984).

Chemical Composition

The chemical composition of the dried leaves as well as the powder was determined, Na and K in the two samples were measured by flame photometer (FP 8000 series, KRUSS optronics Germany), Ca, Ma P by atomic absorption spectrophotometer (GD320N GOLD, LABS China).

Data Analysis

Simple statistical tools of mean and coefficient of variation were used to analyze the values of the parameters determined.

3. Results and discussion

Table 1. Mineral composition (mg) of Baobab leaves (*Adansonia digitata*)

SPECIMEN	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBRE
Powdered	1.44	0.64	0.97
Dried leave	1.63	0.59	0.81
Mean	1.54	0.62	0.89
Range	1.44-1.631	0.54-064	0.81-0.97
Cu	8.7%	5.7%	12.71%

Conclusion

The result shows that powdered leaves obtained from muda lawa market has 1.4 4 % of crude protein, while dried leaves from yelwa market has 1.63 % crude protein with coefficient of variant 8.7 % which is very much within the range. Ether extract of powdered leaves from muda lawan is 0.64 % while that of dried leaves obtained form yelwa market is 0.59 % with coefficient of variant 5.7 %. The result shows that powdered leaves of crude baobab is an excellent and natural source of nutrients.

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Published in the Slovak Republic
Russian Journal of Biological Research
Has been issued since 2014.
E-ISSN: 2413-7413
2018, 5(1): 6-9

DOI: 10.13187/ejbr.2018.1.6
www.ejournal23.com

The Dissemination of Magnitotactic Microorganisms in the Water Reservoirs of Georgia

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Abstract

A search for magnetotactic bacteria was conducted in several water reservoirs of Georgia. At least five species of magnitotactic microorganisms reacting to geomagnetic field have been found. The majority of the organisms move in northern direction.

Light and electron microscopic studies of the morphological features of these microorganisms have indicated that all magnetotactic cells contain magnetic domains, so-called magnetosomes. The shape, dimensions and intracellular guantity of these organeles are species – specific.

Keywords: magnitotactic microorganisms, magnetic domains, magnetosomes, magnetotaxis, eutrophic lakes, microaerophiles, obligate anaerobes, biogenic magnetitis, enriched culture.

1. Introduction

Microorganisms are one of the most interesting and at the same time rarely studied phenomena of the microbial world; they are oriented in the earth's magnetic field and are moving in the direction of magnetic lines of this field. These microbes i. e. Magnetotactic bacteria were discovered by Blakemore in 1975 (Lins de Barro, Eskuivel', 1989). During the last decade a number of researchers have identified some morpho-physiological and biochemical properties of such bacteria (Balkwill, Maratea, 1980; Bazylinski et al., 1988; Blakemore, 1975; Blakemore, 1932). In particular, it has been shown that magnetotactic microorganisms synthesize the magnetic particles within the cell that defines the direction of movement of these bacteria in the Earth's magnetic field (Blakemore, Frankel, 1989). It has been discovered that magnetotaxis is a very common phenomenon in the microbial world and that this feature is characteristic of various forms and sizes of microorganisms in all regions of the earth. Simultaneously, bacterial species found in the north hemisphere tend to move to the North Pole, while in the southern hemisphere – to the south (Bazylinski et al., 1988).

Despite the great efforts, so far the only type of magnetotactic bacteria, Aguaspirillum magnetotacticum MS – 1, was obtained in its pure culture type. This bacterium is spiral-shaped with bipolar flagella and contains a chain of 40-100 nm magnetic particles surrounded by membrane. The X-ray structural and Mössbauer spectroscopy analyses defined that these particles

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represent pure magnetite Fe3O4. The magnetic particles surrounded by the membrane were called "Magnitosome" (Balkwill, Maratea, 1980).

Concurrently, a number of important and interesting issues are completely unresolved. Particularly, what are the transport mechanisms of iron ions into the cells? What factors define the form, size, number and direction of magnetic domains? What is the biological essence of magnetotaxis? What are the peculiarities of the genetic apparatus of magnetotactic bacteria? Can Biogenic Magnetite be used in medical and industrial practice?

Aguaspirillum magnetotacticum is not a favorable object to get a large amount of biogenic magnetite. Its reproduction requires a complex number of components and the use of fine laboratory methods.

All of the above undoubtedly makes the identification and examination of new magnetotactic bacteria urgent. Therefore, we set a goal of our study to research the spread of magnetotactic bacteria in the natural or artificial reservoirs of different regions in Georgia.

2. Materials and methods

We examined magnetotactic bacteria in the following reservoirs: Turtle Lake, Lisi Lake, Tbilisi Water Reservoir, Bazaleti Lake, Nadarbazevi Lake, Jandari Lake, Sioni Reservoir, Zhinvali Reservoir, Sagamo Lake, Paravani, Paliastomi, Batumi Pioneer Park Lake and a large number of small water reservoirs and swampy areas in different regions of Georgia. In total, samples were taken from 47 water reservoirs, and 5-6 samples were taken from each reservoir. Special attention was paid to reservoirs with organic remains, silt and residual vegetation.

The samples were taken in sterile laboratory flasks, so that the ratio of silt and water in the vessel was 1: 3. The test samples were incubated for 1-2 months at a room temperature with poor lighting conditions. Periodically, distilled water was added into the flasks with samples to fill the evaporated water. In addition, the microscopic analyses were conducted to study the presence of magnetotactic bacteria. For this, a constant magnet was attached to the surface of the flask, and the filter device provided by Matsunaga and co-authors (Blakemore et al., 1979; Blakemore et al., 1985) was placed in the flasks.

Detection of magnetotactic bacteria and identification of the direction and speed of their motion were made by the microscope of Nikon TMD-2. A detailed morphological study of bacterial cells was made by electronic microscope JEOL, model JEM 1200 EX using standard methods.

3. Results and discussion

As it is known, in most cases small size of eutrophic lakes and reservoirs, as well as wetland areas with organic compounds provide favourable conditions for magnetotactic bacteria (Kalmijn, Blakemore, 1978). This condition was accepted as a main point for the selection of water reservoirs. In addition, samples were taken from the adjacent areas of northern shores as it is known that in the north hemisphere the magnetotactic bacteria tend to move to north.

The majority of magnetotactic bacteria, found so far, are microaerophiles (Kalmijn, Blakemore, 1978), and in some cases the obligate anaerobes (Matsunaga, Kamija, 1987). That is why the samples were taken from 10-15 cm depth, with appropriate precautions to avoid intense contact with atmospheric air.

As a result, it was identified that in the composition of microflora of six water reservoirs there are microorganisms that react with Earth's magnetic field and to the field that was generated by school magnet. Such microorganisms were found in Jandari, Sagamo and Paravani Lakes, Paliastomi and its adjacent small reservoirs and in the natural lakes on the territory of the Batumi Pioneer Park. All of these water reservoirs are rich in organic waste and silt.

Observations carried out by an optical microscope showed that these microorganisms moved mostly to the north, while their movement speed and trajectory differed significantly from each other. It should be noted that in the reservoir where magnetotactic microorganisms were found, one type of magnetosensitive microbes were prevalent.

The study of the morphology of discovered magnetotactic microorganisms has shown a significant difference in the forms of these bacteria. For example, the bacteria in Jandari Lake have a rod-shape form and contain a single chain of pyramidal magnetic domains, each of which contains 6 magnetosomes with the dimensions 150x50x50 nm.

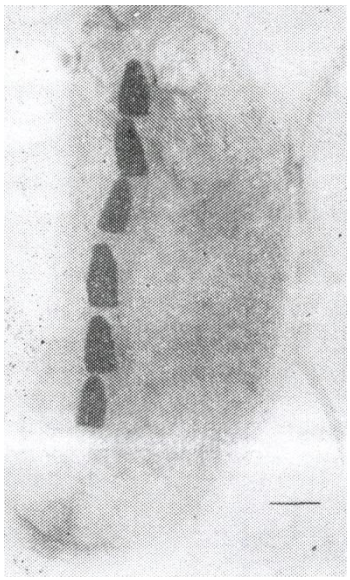

Fig. 1. Magnetotactic bacteria in Jandari Lake

The samples of the Batumi Pioneer Park Lake were particularly rich in magnetotactic bacteria. In certain conditions, these magnetic cocci constituted the absolute majority of microflora in the sample. Their cells contain two chains of cube-shaped magnetic domains. The sizes of magnetosomes were 80x80x100 nm. These bacteria are characterized by a strong flagellar apparatus that is peripherally located.

Long-shaped, single-celled microorganisms, containing a long line of cube-shaped magnetosomes, have been detected in the small reservoirs of Paliastomi Lake and nearby. In the same reservoirs a sphere-shaped magentotactic cells with a large diameter were found; they have high electronic density formations on the surface of the cell. The speed and trajectory of these "giant" cells differ significantly from other magnetotactic microorganisms, but the nature of their interaction with the magnetic field clearly indicates the magnetotactic "behavior".

In Sagamo and Paravana Lakes magnetic spirals were observed that are not fundamentally different from magnetotacticum MS-1 strain found by Blakemore.

Some types of magnetotactic microorganisms detected in Georgia's water reservoirs are described by various foreign researchers (Bazylinski et al., 1988; Paoletti, Blakemore, 1988), but the only type that has been studied in detail is Aguaspirillum magnetotacticum (Balkwill, Maratea, 1980). These bacteria have been obtained as a pure line (Towe, Moench, 1921), which enabled researchers not only to conduct microbiological and morphological studies, but also to examine a number of biophysical and genetic parameters. Execution of such research requires a pure culture of microorganism. At the same time, studying the morphological details of the cells, as well as studying the properties of biogenic magnetitis, it is enough to have enriched culture.

The method provided by Matsunaga, (Blakemore et al., 1979) that was applied in the study, allowed us to obtain such enriched culture. In such way, preparations that primarily contained magnetotactic bacteria were obtained. To study the structure of magnetosomes and organization of cell morphology, the magnetotactic bacteria from Batumi Pioneer Park Lake were selected to get such preparations.

As it was mentioned above, these microorganisms reproduce significantly faster in laboratory conditions and after the incubation period of 1-2 months, their concentration reaches 10^7-10^8 cells / ml. As it is obvious from the results, these cells contain two chains of magnetic domains, in each chain there are 6-10 magnetosomes. All magnetosomes, except for those that are at the ends of the chains, are of equal size. Such distribution of the sizes of magnetosomes indicates the unfinished biomineralization process. In the majority of the bacterial cells of this population, magnetic domains are located in parallel near the surface of the cell. Such deployment of magnetosomes should have some biological essence, as in this case the magnetic moment of bacterial cell is significantly increased. It should be noted here that the magnetic moments of magnetotactic cells

never exceeded 1,3x 10^{12} erg/G (Bazylinski et al., 1988). This phenomenon also has its explanation, because the greater value of magnetic moment could cause the attachment of cells to one another.

In some cases the cells in which magnetosomes were not located in parallel were observed. Also, the cells with three chains of magnetosomes were found. It is not excluded that such changes were caused by cell damage during the preparation of electro microscopic preparations.

In some preparations, magnetotactic cells in the division process were observed. Initially, the number of magnetosomes is doubled and only after that the cell divides into two daughter cells. This process clearly indicates that the formation of magnetosomes and their organization in the cell are genetically determined.

The current research revealed that although studies on magnetotactic bacteria are at the initial stage, the research in this direction can be very interesting both in fundamental and practical terms. The fact that bacterial cells can synthesize magnetic particles with the size of nanometers, explains the prospect of its use in production. The development of new, cheap methods to produce magnetic particles of submicron sizes can have a great impact on many areas of high-tech industry. For example, biogenic magnetite can be used in the manufacture of magnetic tapes, machines with magnetic memory and magnetic circuits, as well as the creation and manufacture of biosensors and different mediators.

The use of biogenic magnetite for practical purposes is the primary task of research in this direction; furthermore, the study of the genetic and biochemical aspects of magnetactic bacteria is very interesting in terms of identification the mechanisms of interaction of living organisms with the magnetic field. It is also important to study magnetotactic bacteria to determine the ways of evolution of life on the Earth.

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Published in the Slovak Republic
Russian Journal of Biological Research
Has been issued since 2014.
E-ISSN: 2413-7413
2018, 5(1): 10-15

DOI: 10.13187/ejbr.2018.1.10
www.ejournal23.com

Effects of *Mangifera Indica* Leaf Extracts on the Biochemical Indices of the Liver Function and Some Haematological Parameters in Rabbits

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Abstract

Research was conducted to study the effect of Magnifera indica dried leaves on two important biochemical indices of the liver, (AST and ALT). Portion of the fractions each was subjected to phytochemical screening for the presence of secondary metabolites including, flavonoids, saponins, tannins and steroids/triterpenes and alkaloids using standard procedures (Silver *et al.*, 1998). A total of 8 rabbits containing four young and four adult rabbits of either sex (2kg) were used for the study. The test animals were divided into four groups of two rabbits each (containing a mixture of one young and one adult rabbit each). T_1 serves as the control, T_2, T_3 and T_4 serving as the test groups. The extract was administered orally to the test groups (T_2, T_3 and T_4) orally and distilled water (placebo) was administered orally to the control group (T_1). The dosage of administration sustained was 200ml/kg daily in divided doses for a month. The ALT & AST test procedure was conducted using RANDOX reagent according to the manufacturer's instruction. Results of preliminary phytochemical of the ethanol (EE) leaf extract of *M. indica* revealed the presence of all the constituent tested including alkaloids, flavonoids, anthraquinones, saponins, steroids, triterpenes, tannins except carbohydrates and glycosides. The aqueous extract (AE) revealed the presence of all the constituents except steroids, triterpenes, anthraquinones, tannins, carbohydrates and glycosides. The results obtained for alanine amino transferases (ALT) and aspartate amino transferases (AST) were found to be within the normal range of 10-45V/L for ALT and 10-120V/L for AST. The packed cell volume (PCV) and hemoglobin concentration were the only heamatological parameters tested. According to the result obtained in the analysis, there was a slight variation between the PCV and Hb concentration in the test animal and the control . Hence, the extract has no adverse effect on the circulating red blood cell as well as the Hb concentration but rather brings about the slight increase in the production of red blood cell as well as the Hb concentration. This may be attributed to the presence of active constituent that promote red cell production in the plant extracts.

Keywords: packed cell volume, heamatological, alamine amino transferase, aspartate amino transferase, phyrochemical.

1. Introduction

Medicinal plants are of great importance to the health of individuals and communities. The medicinal value of these plants lies in some chemical substances or constituents that produce a definite physiological action on the human body (Bhardwaj, Yadav, 2016; Kumar, Rana, 2017).

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Mangiferaindica commonly known as mango belongs to Anacardiaceae family. It is widely distributed in the tropical and subtropical region countries like India (Reddy, Sreedevi, 2016; Ogata et al., 2016). Mangifera indica grows up to 35-40m (115-130ft) tall. It is used for many medicinal purposes as well as dietary functions. The leaves are used as herbal remedy and when soak overnight and drink is reported to have antihyperglycemic activity (Deb et al., 2016; Akhter et al., 2016; Munni et al., 2016). The leaves are astringent, refrigerant styptic, vulnerary and constipating. They are useful in vitiated conditions of cough and pitta, hiccup, hyperdipsia, burning sensation, hemorrhages, haemoptysis, haemorrhoids, wounds, ulcers, diarrhoea, dysentery, pharyngopathy, scorpion string and stomachopathy. The ashes of burnt leaves are useful in burns and scalds. A powder of tender leaves is given in diarrhoea and diabetes. The smoke from burning leaves is inhaled for relief in hiccup and throat diseases (Rajasekaran, Mahimaidoss, 2016; Parvez, 2016). The roots and bark are astringent, acrid, refrigerant, styptic, antisyphilitic, vulnerary, anti-emetic, anti-inflammatory and constipating. They are useful in vitiated conditions of pitta, metrorrhagia, calonorrhagia, pneumorrhagia, lecorrhoca, syphilis, uteritis, wounds, ulcers and vomiting. The juice of fresh bark has a marked action on mucous membranes, in menorrhoea, leucorrhoca, bleeding piles and diarrhoea. An ointment of resinous gum of tree bark is dressing for scabies and other parasitic skin diseases (Macfoy, 2013; Eluwa et al., 2014).

The unripe fruits are acidic, acrid, antiscorbutic, refrigerant, digestive and carminative. They are useful in dysentery ophthalmia, eruptions, urethrorrhoea and vaginopathy. Sun dried slices of unripe fruits are excellent remedy for scurry while fried skin of unripe fruit is given in menorrhages. The ripe fruits are refrigerant, sweet, emollient, laxative, cardiotonic, haemostatic, aphrodisiac, and tonic. They are used in vitiated conditions vata and pitta, anorexia, dyspepsia, cardiopathy, haemoptysis, haemorrhages from uterus, lungs and intestine, emaciation and anemia. Rind of fruit is astringent, stimulative, tonic and useful in general debility of stomach (Macfoy, 2013; Eluwa et al., 2014). The flowers are astringent, refrigerant, styptic, vulnerary, constipating and haematinic. The dried flowers are useful in vitiated conditions of pitta, haemorrhages, haemoptysis, wounds, ulcers, anorexia, dyspepsia, uro-edema gleet, catarrh of bladder, diarrhoea, chronic dysentery, and anaemia, The seed kernel in rich source of protein (8.5 %) and gallic acid, it is sweet, acrid, astringent, refrigerant, anthelmintic, constipating, haemostatic, vulnerary and uterine tonic. The medicinal purposes of *Mangiferaindica* have been widely studied, *Mangiferaindica* leaf extract inhibited lipid peroxidation (Núñez Selles et al., 2016; Lauricella et al., 2017 ; Lauricella et al., 2017), exerted antifungal activity (Ahmed et al., 2016), exhibited antiulcerogenic action (Lauricella et al., 2017 ; Lauricella et al., 2017). It was also reported as an anti-gouty arthritis agent, antidiabetic agent and management of gastro-intestinal disorders (Pal et al., 2016).

Blood is an important index of physiological and pathological changes in an organism (Raina, 2016; Pal et al., 2016). The primary function of the blood is to transport oxygen from respiratory organs to body cells (López-Barneo et al., 2016; Lumb, 2016), distributing nutrients and enzymes to cells and carrying away waste products , thereby maintaining homeostasis of the internal environment (Olivier, 2017). The various functions of the blood are carried out by the individual and collective actions of its constituents – the haemotological and biochemical components (Pitsikas, 2016; Singh et al., 2017). Haematological tests have been widely used for the diagnosis of various diseases and nutritional status of animal. The information gained from the blood parameters would substantiate the physical examination and together with medical history provide excellent basis for medical judgment (Kurtz et al., 2016 ; Silverman et al., 2016 ; Goodman et al., 2017).

Therefore, the aim of the present study was to determine the effect of *Mangiferaindica* leaf extract on the biochemical indices of liver function and some haematological parameters in rabbits.

2. Materials and methods

Experimental Site

The research work was carried out at Chemistry/Biology Laboratories of the School of Science and Technology, AbubakarTatari Ali Polytechnic and Pathology Laboratory section of Darusssalam Health Clinic Center, DutsenTanshi Bauchi, Bauchi State, Nigeria.

Collection and Identification of Plant Material

Fresh leaves of *M. indica* were collected from the schools garden. The identification and authentication of the plant was done by a Botanist, Ibrahim Shuaibu, College Agriculture, Bauchi. The leaves were sorted, shade dried, pulverized to powder and stored in a clean container for onward analysis.

Extraction

Extraction with ethanol

The Powdered leaves (200 g) were extracted with 400ml ethanol using maceration method for 2days with occasional shaking. The extract was filtered using Whatmann No. 1 filter paper and the filtrate was freed from solvent with the aid of a water bath (30-40^{o}C) to obtain a gummy greenish product (28 g) subsequently referred to as the crude ethanol extract (EE).

Extraction with distilled water

The Powdered leaves (100 g) were extracted with 200ml distilled water using maceration method for 2days with occasional shaking. The extract was filtered using Whatmann No. 1 filter paper and the filtrate was freed from solvent with the aid of a water bath (30-40 ^{o}C) to obtain a gummy greenish product (28 g) subsequently referred to as the aqueous extract (AE).

Preliminary Phytochemical Investigation

Portion of the fractions each was subjected to phytochemical screening for the presence of secondary metabolites including, flavonoids, saponins, tannins and steroids/triterpenes and alkaloids using standard procedures (Silver et al., 1998).

Test for Alkaloids

0.5g of the extract was stirred with 5ml of 1 % aqueous hydrochloric acid on a water bath and filtered. 3ml of the filtrate was divided into two. To the first 1ml few drops of freshly prepared Dragendoff's reagent was added. To the second, 1 drop of Meyer's reagent was added and observed.

Test for Flavonoids and Phenols

Ferric chloride test: To a small portion of the extract, distilled water was added. A drop of ferric chloride was added to a solution of the extract and observed.

Test for Anthraquinones 0.5 g of the extract was shaken with 5ml carbon tetrachloride, this was filtered and 10 % dilute ammonia solution was added. The mixture was shaken and observed.

Test for Saponins 0.5g of the extract was shaken with distilled water in a test tube. It was allowed to stand for 10 minutes and observed.

Test for Steroids and Triterpenes *Liebermann-Buchard test*: A small portion of the extract was dissolved in chloroform. Equal volume of acetic anhydride and concentrated H_2SO_4 were added down the test tube and observed.

Test for Tannins *Lead Sub-acetate Test*: To a small portion of the extract, distilled water was added. 3-5 drops of lead acetate solution was added and observed.

Test for Carbohydrates *Fehling's Test*: To a small portion of the extract, distilled water was added. 2ml Fehling's

Test for Glycosides *Legal's test*:To a small portion of the extracts, sodium nitropruside in pyridine and sodium hydroxide was added and observed.

Preparation of Animal Sample

A total of 8 rabbits containing four young and four adult rabbits of either sex (2kg) obtained in Bauchi metropolis were used for the study. They were kept in the School Laboratory Garden for 40 days so as to acclimatize with the environment. The test animals were divided into four groups of two rabbits each (containing a mixture of one young and one adult rabbit each). T_1 serves as the control, T_2, T_3 and T_4 serving as the test groups.

Mode of Administration and Dosage

The extract was administered orally to the test groups (T_2, T_3 and T_4) orally and distilled water (placebo) was administered orally to the control group (T_1). The dosage of administration sustained was 200ml/kg daily in divided doses for a month .

Blood Collection Procedure The blood was collected from the central auricular artery (ear) with a 20g needle. Vasolidation was achieved with the aid of heating lamps, 70 % alcohol swabs and warm compression.

Liver Function Test (ALT & AST) using Randox Reagent

The ALT & AST test procedure was conducted according to the manufacturer's instruction in the following three steps;

Step 1: Two test tubes were set as TEST and BLANK. 200 U/L of reagent 1 was added to both test tubes. To the TEST tube, 40 U/L of serum was added to it and 40 U/L of distilled water to the BLANK tube and incubated at 37^{o}C in water bath for 35 minutes.

Step 2: 200 U/L of reagent 2 was added to both the TEST and BLANK tubes, incubated for 20 minutes at room temperature

Step 3: To the TEST and BLANK tubes, 2000 U/L of sodium hydroxide (NaOH) solution was added and incubated for 5 minutes at room temperature. The result was displayed at 530 mm with the aid of photoelectric colorimeter. ALT and AST were calculated below;

ALT (U/L) = Optical density of sample mixture × concentration = OD of sample mixture x 160

AST (U/L) = Optical density of sample mixture × concentration = OD of sample mixture x 350

PCV

Capillary tube (75mm) was filled to approximately with EDTA and anticoagulated blood (3 quarter of its length). The excess blood was wiped from the outside of the tube and scatted with a sealer. The tubes were placed in a microhaematocrit centrifuge with the sealed end pointing outwards. The inner lid was firmly secured and the outer lid was also closed and centrifuge for five minutes at 11,000 revolutions per minute. When the centrifuge stopped, the tubes were removed and read as the fraction of red cells column to the total length of the sample.

3. Results and discussion

The result of phytochemical screening, effects of *Mangiferaindica* leaf extracts on rabbits serum enzymes and haematological indices are presented in Tables 1-3 respectively;

Table 1. Phytochemical Constituents of Ethanol and Aqueous Extracts of *M. indica*

Constituents	**Test**	**Observation**	**Inference**	
			EE	**AE**
Saponins	Frothing	Frothing persist for 15mins	+	+
Alkaloids	Mayer's Draggondorf's	White-cream ppt Orange ppt	+ +	- -
Flavonoids	$FeCl_2$	Green or violet ppt	+	+
Tannins	Lead subacetate	Cream ppt	+	+
Steroids & Terpenes	Lieberman-Buchard	Blue-green color at interphase	+	-
Anthraquinones	Borntragers	Pink or violet	-	-
Carbohydrates	Molisch's Fehling's	Reddish ring Red	-	-
Phenols	$FeCl_2$	Bluish black color	+	+
Glycosides	Fehling's	Red ppt	-	-

Table 2. Effect of *M. indica*leaf extracts on rabbit serum enzyme

Group	**ALT (u/L)**	**AST (u/L)**
T_1	12.80	21.00
T_2	12.80	31.50
T_3	16.00	17.50
C	17.60	17.50
Normal range	10-45	10-120

Key: T=Test; C=Control

Table 3. Effect of *M. indica*leaf extracts on rabbit haematological indices

Group	PCV (%)	HB (g/dl)
T_1	44	14.60
T_2	41	13.70
T_3	46	15.30
C	36	15.30
Normal range	33-50	94-174

The result of preliminary phytochemical of the ethanol (EE) leaf extract of *M. indica* revealed the presence of all the constituent tested including alkaloids, flavonoids, anthraquinones, saponins, steroids, triterpenes, tannins except carbohydrates and glycosides. The aqueous extract (AE) revealed the presence of all the constituents except steroids, triterpenes, anthraquinones, tannins, carbohydrates and glycosides. These constituents have been reported to be responsible for most biological activities of plants (Cowan, 1999).

The results obtained for alanine amino transferases(ALT) and aspartate amino transferases (AST) were found to be within the normal range of 10-45V/L for ALT and 10-120V/L for AST. However, there was no significant alteration with the level of the serum enzymes in the control rabbit which is an indication that the extract of *M. indica*did not alter the stoichiometry of the liver marker enymes and the liver.The packed cell volume (PCV) and hemoglobin concentration were the only heamatologicalparameters tested. According to the result obtained in the analysis, there was a slight variation between the PCV and Hb concentration in the test animal and the control . Hence, the extract has no adverse effect on the circulating red blood cell as well as the Hb concentration but rather brings about the slight increase in the production of red blood cell as well as the Hb concentration. This may be attributed to the presence of active constituent that promote red cell production in the plant extracts.

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Published in the Slovak Republic
Russian Journal of Biological Research
Has been issued since 2014.
E-ISSN: 2413-7413
2018, 5(1): 16-19

DOI: 10.13187/ejbr.2018.1.16
www.ejournal23.com

Determination of Cadmium and Mercury Contamination Level in the Fish of the River Mtkvari

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Abstract

The Mtkvari is the biggest transboundary river in Transcaucasia,originating in Turkey and flowing through Georgia to Azerbaijan. The river is antropogenically polluted and our research aimed to assess the Hg and Cd contamination threat in its water. These heavy metals are significant environmental contaminants and therefore, even their low concentrationsmight are lethal for fish and other water entities.

The research findings showed that there were no Hg and Cd concentrations even in the most antropogenically impacted areas (Zahesi, Vakhushti bridge, Ortachala, Gachiani) of Tbilisi city. Although, small concentrations of these heavy metals were detected in the samples of the fish tissues, taken from the same sample sites, which is caused by the cumulative effect, characteristic of fish. Based on the findings, even in the most anthropogenically impacted regions of the river Mtkvari, there was no concentration of cadmium and mercury detected. There were various fish species that were not contaminated, however it should be mentioned that the cadmium and mercury bioaccumulation process in fish may take place easily and quickly. Fortunately, there are not many industrial processes in Georgia which could cause further ecosystems contamination with cadmium and mercury. Thus, contamination with heavy metals is almost impossible in the Georgian rivers, water ecosystems, hydrobionts and their populations, and the reservoir's bio-communities.

Keywords: the river Mtkvari, cadmium, mercury.

1. Introduction

The irreversible process of technological progress and urbanization increases pollution in man-made water reservoirs and the contaminants from widespread use of chemicals and heavy metals in agriculture, then damage the ecosystems of the rivers. Among the most hazardous of heavy metals are cadmium and mercury, which will be discussed in this study.

In the environment, inorganic mercury can be converted to metal organic compounds and among these compounds, toxic methyl silver is one of the most toxic. It is produced in water due to the biological processes there and through trophic chain transfers from the fish and other water entities to human organisms. As soon as Hg appears in the water, contaminated with organic pollutants, its methylation process starts and it is converted to methyl or dimethyl mercury (CH_3Hg, CH_3HgCH_3), which are the most toxic forms of elemental mercury. Hg contamination of

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rivers is extremely harmful for the fish and other life forms in the water. Moreover, due to its easily soluble nature in fish oil, it is lethal for other living organisms when consumed. It should be mentioned that Hg poisoning is not a rare occurence. The best-known instances of Hg poisoning were in Niigata and Minamata, Japan, when a highly toxic mercury compound was released into the Agano *River*, resulting in the death of thousands of people.

It should be noted that soon Georgia will sign the Minamata Convention and will be obligated to perform the requirements from the convention and create a detailed report regarding the potential threats of Hg contamination in the country. Therefore, to conduct these water contaminant studies in Georgia is a matter of great importance.

Cd is a significant environment pollutant and toxic for hydrobionts and human beings. Even in low concentrations, Cd can still be lethal for fish and entities in the contaminated water. Furthermore, low concentrations of Hg and Cd can have serious toxic effect. Their bioaccumulation and biomagnifications are dangerous to human health and under the influence of natural processes they can become even more hazardous. Due to their persistent nature, they can also have a destructive impact on the environment and cause poisoning of water ecosystems, kill fish, pollute and deteriorate local landscapes.

Our research, conducted at several of the most polluted regions of the river Mtkvari in Georgia, aimed to assess Hg and Cd accumulation level in the fish of the river Mtkvari.

2. Discussion

Research method Colorimetric method (GOST 26927-86) for determination of mercury in the fish samples and atomic absorption method (GOST 30178-96) for determination of cadmium concentration.

The research findings and review: The research was conducted in October, 2017 and the water and fish samples were taken from several sample sites for the purpose of chemical analysis to determine Hg and Cd contamination. The following sites were selected for conducting the research: Zahesi bridge; Vakhushti bridge; Ortachala area; Gachiani.

Table 1. Hg contamination in the fish tissue samples from the river Mtkvari

№	Place sample was taken	Time sample was taken	Finding. mg/kg	Maximum permisible concentration mg/kg	Comment	Method
1	The river Mtkvari (Zahesi bridge,Tbilisi)	16.10.2017	0.005	0.5	Weight of taken samples – 350 gr.	26927-86
2	The river Mtkvari, Tbilisi (Vakhushti bridge)	16.10.2017	0.004	0.5		
3	The river Mtkvari (Ortachala area)	16.10.2017	0.0065	0.5		
4	The river Mtkvari, Gachiani	16.10.2017	0.007	0.5		

Based on the findings, there is no cadmium and mercury concentration in the river Mtkvari. However, Hg concentration was detected in the fish tissue samples, taken at different sample sites in Tbilisi and there are few differences between the findings at both sites. On average, Hg concentration in the fish samples is 006 mg/kg, which is much lower that maximum permissible concentration of 0.5 mg/kg. The findings show, that the water sample from a certain site might not be Hg contaminated, but Hg traces can be detected in the fish tissue sample from the same site. Therefore, it can be concluded, that fish have the ability to absorb Hg quickly and accumulate it in their tissues. According to the data in diagram 1, Hg concentration in the fish increases as the stream of the river flow increases – Hg contamination level in the fish is increased in the greater city area of the river Mtkvari.

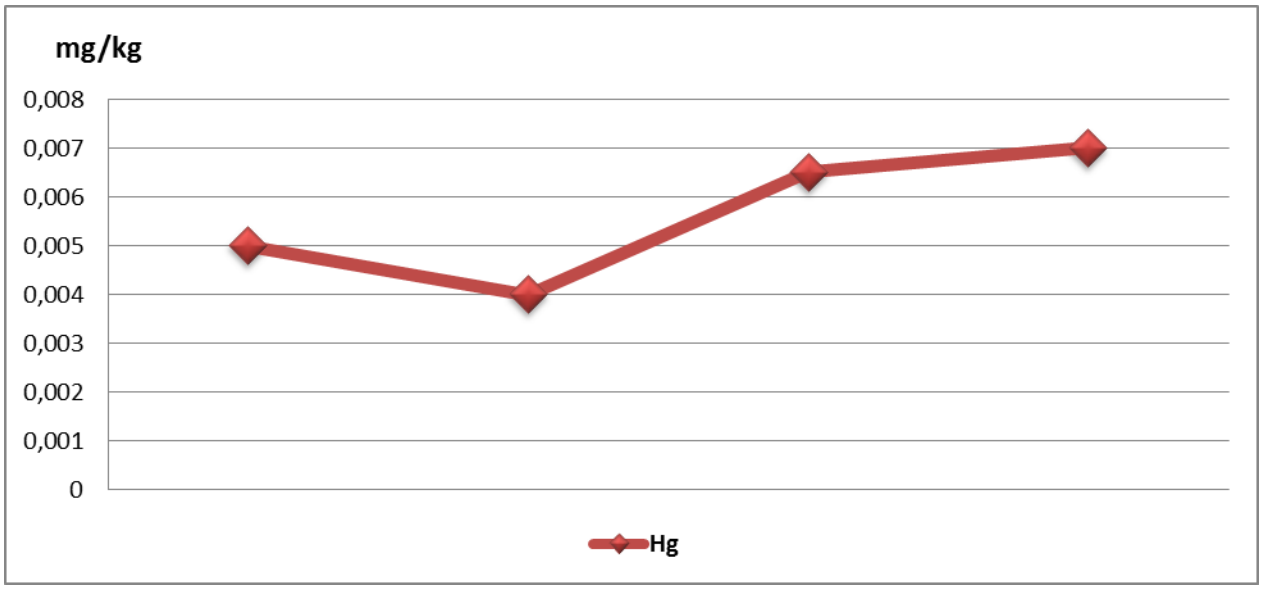

Fig. 1. Hg contamination in the fish tissue samples from the river Mtkvari

Our research findings are relevant and foundational in determining the levels of Hg contamination in the fish of the river Mtkvari, as well as fish in other bodies of water, because it has not previously been conducted in Georgia. Additionally, another research was conducted to determine Cd concentration in the fish from the river Mtkvari. See the findings in the Table 2.

Table 2. The findings

№	Place sample was taken	Time sample was taken	Finding. mg/kg	Maximum permisible concentration mg/kg	Comment	Method
1	The river Mtkvari (Zahesi bridge, Tbilisi)	16.10.2017	0.0110	0.05	Weight of taken samples – 350 gr.	30178-96
2	The river Mtkvari, Tbilisi (Vakhushti bridge)	16.10.2017	0.0112	0.05		
3	The river Mtkvari (Ortachala area)	16.10.2017	0.0116	0.05		
4	The river Mtkvari, Gachiani	16.10.2017	0.0118	0.05		

The highest concentration of Cd (0,0118 mg/kg) detected in the fish tissue, taken from Gachiani sample site, is much lower than maximum permissible concentration (0,05 mg/kg) and an even lower concentration (0,0110 mg/kg) was detected in the fish samples taken from the sample site near Zahesi bridge. The findings show that Cd concentration in the fish rises more sharply with the increased river flow than in case of Hg (Figure 2). It should also be noted, that once absorbed Cd displaces Ca, which is a vital element in the formation and maintenance of bones and can cause bone demineralization and other undesirable changes at the cellular level.Diagram shows the tendency of Cd contamination in the fish of the river Mtkvari.

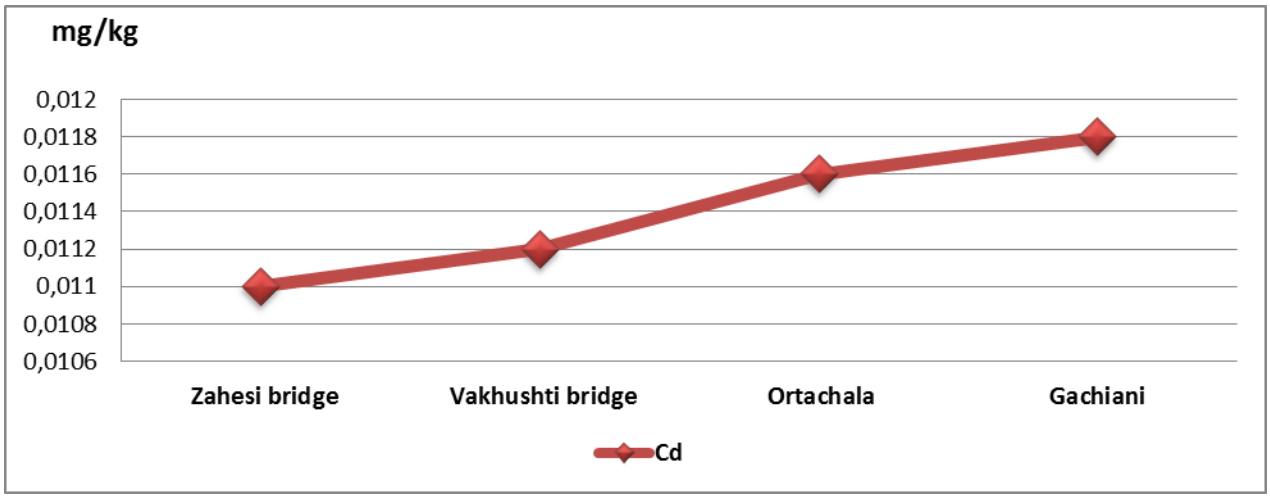

Fig. 2. Cd contamination in the fish tissue samples from the river Mtkvari

3. Conclusion

The research findings show that a cumulative action-accumulation of toxic substances – is characteristic of fish and the toxins, even when Cd and Hg concentration in the water is very low it still influences them. As hydrobionts concentrate toxins in the body, they become toxic to the host.

Based on the findings, even in the most anthropogenically impacted regions of the river Mtkvari, there was no concentration of cadmium and mercury detected. There were various fish species that were not contaminated, however it should be mentioned that the cadmium and mercury bioaccumulation process in fish may take place easily and quickly. Fortunately, there are not many industrial processes in Georgia which could cause further ecosystems contamination with cadmium and mercury. Thus, contamination with heavy metals is almost impossible in the Georgian rivers, water ecosystems, hydrobionts and their populations, and the reservoir's bio-communities.

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Published in the Slovak Republic
Russian Journal of Biological Research
Has been issued since 2014.
E-ISSN: 2413-7413
2018, 5(1): 20-26

DOI: 10.13187/ejbr.2018.1.20
www.ejournal23.com

Ecological Monitoring of the River Khrami Water and Anthropogenic Load

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Abstract

The river Khrami, a right tributary of the Kura river, has vital importance for Kvemo Kartli region. The river Khrami irrigates thousand hectares of arable land and is used as drinking water in the villages. That is why, it is very important to maintain its ecological relevance.

Based on the monitoring data from 2016-2017, it can be concluded, the ecological condition of the river Khrami is highly affected by one of its tributaries – the Mashavera river. The Mashavera river flows in the vicinity of mining quarries. The water of the river Khrami is of hydrocarbonate – type, high in calcium. The nitrogen level and biological oxygen consumption do not exceed the permissible limit. The soluble forms of the heavy metals change but their concentration do not exceed the permissible limit which is conditioned due to the high pH of the river water, which hydrolyzes heavy metals and their main part precipitates on the bottom and the rest is sorbed on floating debris. The anthropogenic substances in the riverThe anthropogenic substances in the river Khrami, are transformed into non-toxic admixtures due to chemical, physical-chemical and biological processes. Organic and biogenic substances are oxygenated or consumed by life forms. Due to this or the process, called self-purification, the ecological condition of the river is satisfactory.

Keywords:The Khrami river, heavy metals, biogenic compounds, hydrochemistry, main ions of natural water, anthropogenic pollution.

1. Introduction

The river Khrami is a righttributary of the Kura river and flows in Eastern Georgia. The river Khrami originates in the Trialeti range and flows into a deep valley. It is 201 km long, water basin is 8340².km, its average consumption is 51 cubic meter/second,maximum consumption448 cubic meter/second. It is fed by snow, does not freeze in winter and its lower part is used for irrigation. The Tsalka Reservoir and three hydroelectric power plants are built on the Khrami.Its tributaries – the Debeda and Mashavera rivers have important impact on its structure (Gigineishvili, 1987).

The river Khrami is an important water source for KvemoKartli and nearly its every cubic meter is registered. Today, the water of the river Khrami is used as drinking water in many villages and even more villages plan to use it for the same purpose (Mchedluri, 2009). Thousand hectares of arable landis irrigated by the river Khrami and thousand hectares more are planned to be, dispite the growing irrigation water scarcity. The villages “linked” to the river Khrami, are settled

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with Azeri population, who are mainly engaged in agriculture, as the main source of their income, and the river flow reduction threatens their basic food security.

2. Materials and methods

Chemical analyzes of the river Liakhvi water were carried out using modern methods, which meet and come into compliance with European standards, such as ion-selection chromatography – ICS-1000) ISO100304-1: 2007; Spectrometer – SPECORD 205ISO7150-1: 2010; Membrane filtration – ISO9308-1, ISO 7899-2; Atomic absorption spectrometer – ICP-MS; Portable Field Office HORIBA-10 (ISO 6058:1984; ISO 6059:1984; ISO 9297:1989).

3. Results and discussion

The monitoring of the river Khrami water was conducted seasonally in 2016-2017. The research was conducted at two sites: Khrami – Imiri (№1) and Khrami– Red Bridge (№2), and the samples were taken in four different seasons of the year (winter, spring, summer and autumn).

The physical-chemical characteristics, such as – t°C, pH; hydrochemical parameters-salinity, transparency, mineralization, dissolved oxygen (Do) and so on; biogenic elements – NO_2^-, NO_3^-, NH_4^+, PO_4^{3}; main ions of natural water – Na^+,K^+, Ca^{2+}, Mg^{2+}, Cl-,SO_4^{2}, HCO_3^-) and heavy metals - Fe,Cu,Zn,Mn,Pb) were measured in the samples. The findings are given in the Tables 1, 2 and Figures 1-2.

Table 1. The river Khrami water hydrochemical research findings (2016)

Description	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khram iImiri
№	1	2	1	2	1	2	1	2
Time of taking samples	winter	winter	spring	spring	summer	summer	autumn	autumn
Temperature. t°C	5.46	6.5	13.1	11.8	23.8	21.8	6.9	6.6
Hardness. mg. eq/l	4.41	3.77	3.67	3.96	4.42	3.70	3.86	3.30
Smell. degree	0	0	0	0	0	0	0	0
Transparency. cm	10	10	9	7	11	11	11	10
Weighed up particles mg/l	-	-	70.2	125.2	-	-	-	-
pH	8.41	8.24	8.58	8.36	8.1	8.30	7.83	8.11
Carbonate. mg/l	2.1	1.5	3.3	2.4	1.2	2.4	-	-
Dissolved oxygen mgO_2/l	11.5	11.8	9.8	9.8	5.8	5.16	11.3	10.7
Oxygen saturation level%	111	116	96	95	70	61.2	91	85
Biochemical Oxygen $demand_5$. mgO_2/l	1.56	0.79	0.63	0.87	1.49	2.16	2,08	1,34
NNitrite NitrogenmgN/l	0.041	<0.001	0.022	0.048	0.011	0.002	0.020	0.039
Nitrate Nitrogen. mgN/l	2.289	2.211	1.312	1.744	1.623	0.214	2.178	1.955
Ammoniacal nitrogen. mgN/l	0.322	0.331	0.159	0.421	0.268	0.281	0.262	0.211
Phosphate. mgP/l	<0.001	<0.001	1.112	0.038	0.041	0.144	0.062	0.256
Sulphates.mgSO_4^{--}/l	71.22	43.91	0.040	36.11	89.64	35.51	71.78	50.15

Chlorides. mgCl/l	10.70	8.47	44.52	6.99	12.86	8.28	10.18	8.05
Fluorine.mg/l	0.006	0.150	6.242	0.186	0.322	0.155	0.122	0.141
Hydrocarbonates mg HCO_3/l	223.04	198.20	188.82	206.92	234.55	230.16	227.9	166.49
Potassium.mg/l	1.7	1.4	1.2	1.1	1.8	1.5	1.4	1.2
Sodium.mg/l	25.5	18.5	14.6	10.5	22.5	12.9	26.6	15.8
Calcium. mg/l	60.01	51.28	52.93	56.73	68.56	46.44	56.62	46.55
Magnesium. mg/l	14.84	16.58	14.24	15.22	12.88	12.82	14.80	12.96

Table 2. The river Khrami water hydrochemical research findings (2017)

Description	**Khrami Red Bridge**	**Khram iImiri**	**Khrami Red Bridge**	**Khrami Imiri**	**Khrami Red Bridge**	**Khrami Imiri**	**Khrami Red Bridge**	**Khrami Imiri**
№	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Time of taking samples	**winter**	**winter**	**spring**	**spring**	**summer**	**summer**	**autumn**	**autumn**
Temperature. t°C	6.12	6.18	13.2	12.4	22.6	20.2	6.1	6.5
Hardness. mg. eq/l	3.98	3.47	4.27	3.86	4.12	3.20	3.66	3.32
Smell. Degree	0	0	0	0	0	0	0	0
Transparency. cm	8	8.5	9.1	8	10	11	9	10
Weighed up particles. mg/l	-	-	70.2	125.2	-	-	-	-
pH	8.11	8.15	8.28	8.30	8.12	8.15	7.88	8.10
Carbonate. mg/l	2.2	1.9	3.1	2.6	1.4	2.5	-	-
Dissolved oxygen. mg O_2/l	11.0	11.3	9.1	8.8	5.2	5.12	11.2	11.0
Oxygen saturation level %	102	114	94	93	68	61.0	90	82
Biochemical Oxygen demand$_5$ (BOD) mg O_2/l	1.55	0.89	0.66	0.89	1.52	2.33	2,16	1,58
NNitrite Nitrogen. mgN/l	0.052	0.002	0.025	0.066	0.018	0.004	0.024	0.044
Nitrate Nitrogen. mgN/l	2.423	2.231	1.328	1.735	1.539	0.211	2.188	2.244
Ammoniacal nitrogen. mg N/l	0.342	0.334	0.163	0.577	0.382	0.488	0.274	0.308
Phosphate. mg P/l	<0.001	0.055	1.114	0.048	0.046	0.126	0.066	0.288
Sulphates.mg SO_4^{--}/l	75.68	49.22	48.34	39.66	99.34	47.54	78.73	54.66
Chlorides. mgCl/l	12.70	8.44	19.59	6.90	12.88	7.36	11.19	8.04

Fluorine. mg/l	0.084	0.282	5.148	1.180	0.4 28	0.178	0.128	0.152
Hydrocarbonates. Mg HCO_3/l	221.14	198.25	180.82	206.98	220.50	239.30	230.8	168.28
Potassium. mg/l	1.8	1.6	1.6	1.7	1.6	1.4	1.2	1.8
Sodium.mg/l	18.5	17.6	14.8	10.5	22.6	18.5	18.0	17.5
Calcium. mg/l	62.78	48.28	44.96	58.11	68.44	56.14	55.13	56.51
Magnesium. mg/l	12.38	18.55	14.44	17.36	14.80	11.82	12.88	12.33

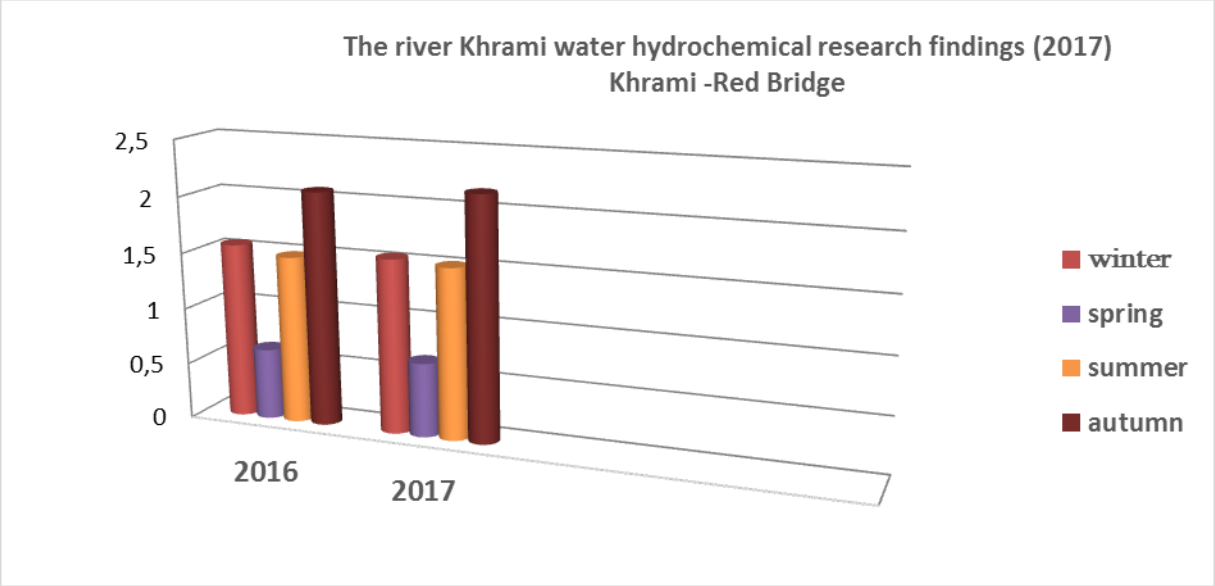

Fig. 1. Seasonal changes of BOD in the water of the river Khrami (Red Bridge)

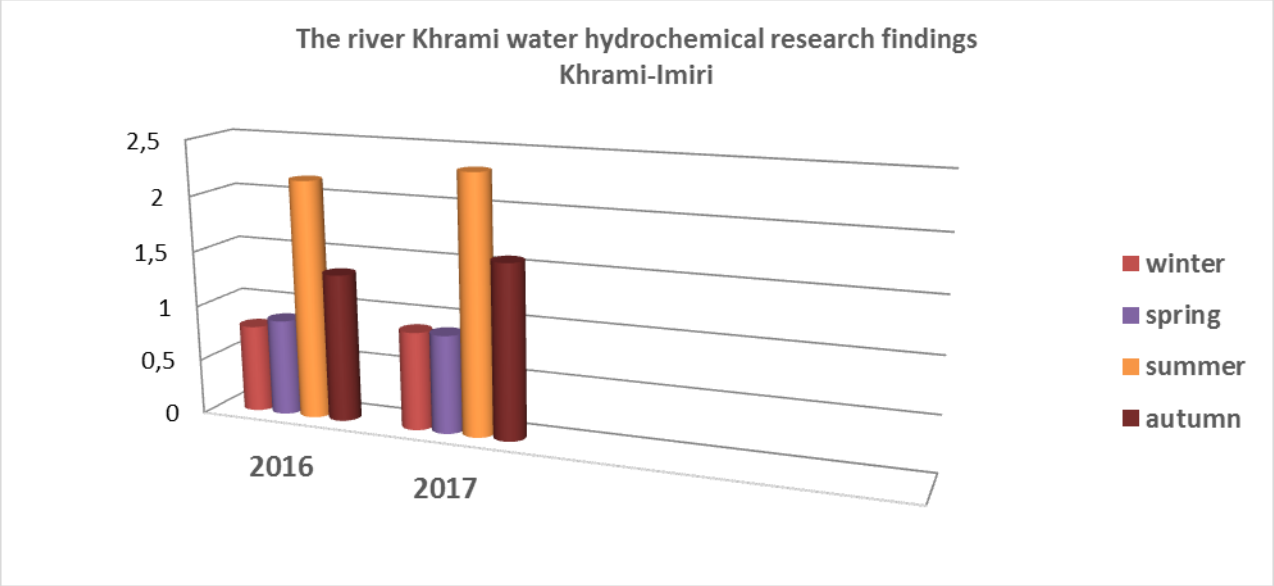

Fig. 2. Seasonal changes of BOD in the water of the river Khrami (Imiri)

The Mashaverariver, used for irrigation, joins the river Khrami at the village Nakhiduri. There are 5 irrigation systems on this river, which irrigate 7440 hectaresof Bolnisi and Marneuli cultivable land. The Kazretula river, which is very contaminated with heavy metals, joins the river Khrami as well. This river flows near the vicinity of regions with mining quarries. Heavy metals and acid water are penetrated in its water from the Sakdrisi gold mining quarry (Mchedluri, 2012).

That is why, it is important to measure the concentration of certain heavy metals in the river Khrami water. The monitoring of the river Khrami was conducted Khrami-Imiri (№1)and Khrami-Red Bridge in 2016-2017. The concentration of several heavy metals, specific for the region, was measured in the taken water samples and the findings are given in the Tables 3-4 and a Figure 3.

Table 3. Concentration of certain heavy metals in the water of the river Khrami (2016)

Description	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khrami Imiri	Khrami Red Bridge	Khram iImiri	Khrami Red Bridge	Khrami Imiri
№	1	2	1	2	1	2	1	2
Time of taking samples	spring	spring	summer	summer	autumn	autumn	autumn	autumn3
Iron mg/l	0.2098	0.4158	0.2194	0.1096	0.0933	0.0683	0,1700	0,2073
Zinc mg/l	0.0293	0.0317	0.0417	0.0093	0.0090	0.0065	0,0108	0,0078
Coppermg/l	0.0236	0.0128	0.0240	0.0085	0.0099	0.0034	0,0073	0,0048
Leadmg/l	0.0013	0.0011	0.0054	0.0042	0.0011	0.0038	0,0027	0,0018
Manganeseml/l	0.0464	0.0422	0.0797	0.0090	0.0064	0.0050	0,0069	0,0087

Table 4. Concentration of certain heavy metals in the water of the river Khrami (2017)

Description	Khrami Red Bridge	Khram iImiri	Khrami Red Bridge	Khram iImiri	Khrami Red Bridge	Khram iImiri	Khrami Red Bridge	Khrami Imiri
№	1	2	1	2	1	2	1	2
Time of taking samples	Spring	spring	spring	spring	summer	summer	autumn	autumn
Iron mg/l	0.2228	0.3877	0.2290	0.1198	0.1732	0.0723	0,1805	0,2570
Zinc mg/l	0.0256	0.0312	0.0398	0.0089	0.0099	0.0055	0,0138	0,0070
Copper. mg/ლ	0.0211	0.0202	0.0248	0.0088	0.0091	0.0045	0,0080	0,0068
Lead. mg/l	0.0018	0.0014	0.0048	0.0044	0.0021	0.0040	0,0032	0,0020
Manganese. mg/l	0.0457	0.0445	0.0782	0.0086	0.0066	0.0058	0,0077	0,0079

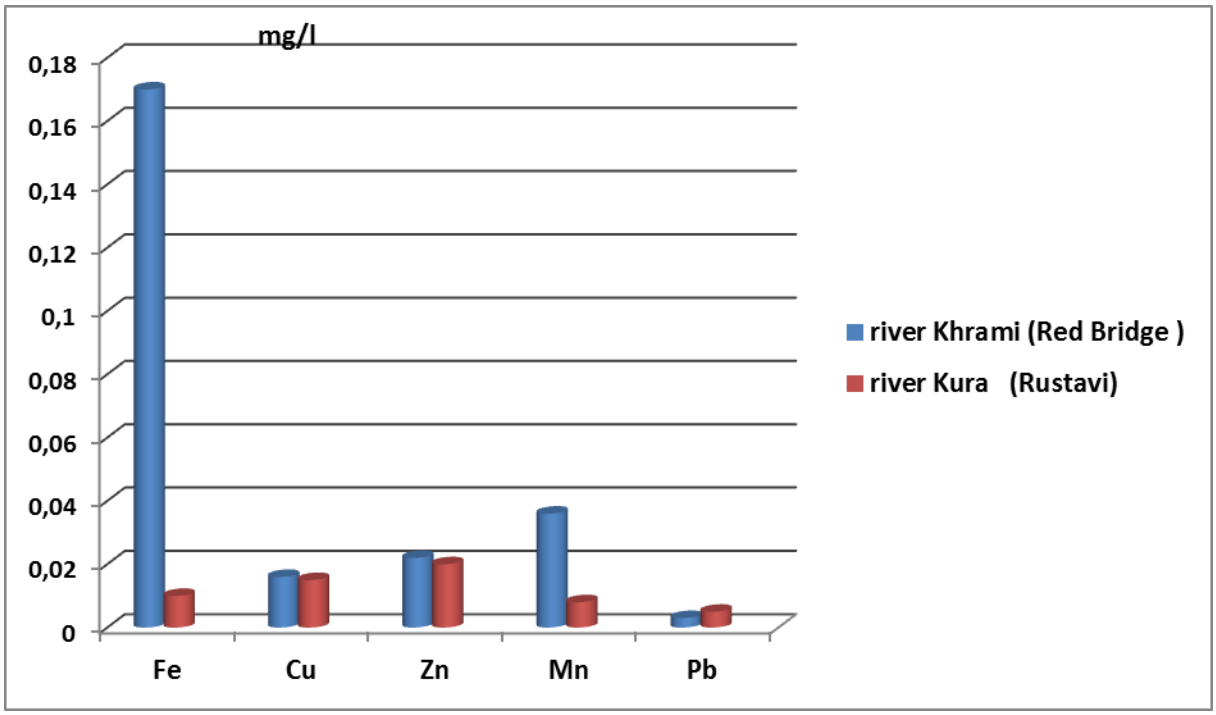

Fig. 3. Comparative study of certain heavy metals' concentration in the water of the Kura river and the river Khrami

Predictably, concentration of heavy metals in the river Khrami was higher than in the Kura river as it is given in the Figure 3. The Figure 3 shows that iron concentration in the water of the river Khrami was 15 times higher than in the Kura river, manganese concentration 4.5 times higher and so on. Although, their concentration did not exceed the maximum permissible level due to the high pH of the river water.

4. Conclusion

Based on the research findings, it can be concluded that the river Khrami water is a hydrocarbonate-type, high in calcium. The nitrogen level and biological oxygen consumption do not exceed the permissible limit.

After completing the study on the heavy metals concentration, it can be concluded that the ecological condition of the river Khrami is highly affected by one of its tributaries – the Mashaverariver.Mining quarries and Sakdrisi gold mining quarry have serious anthropogenic impact as well, due to which the concentration of certain metals in the river Khrami water is higher than in the Kura river (city Rustavi). Although, the heavy metals concentration in the river water does not exceed the permissible level.

According to the monitoring findings, the soluble forms of the heavy metals change but their concentration do not exceed the permissible limit which is conditioned due to the high pH of the river water, which hydrolyzes heavy metals and their main part precipitates on the bottom and the rest is sorbed on floating debris.The anthropogenic substances in the river Khrami, are transformed into non-toxic admixtures due to chemical, physical-chemical and biological processes. Organic and biogenic substances are oxygenated or consumed by life forms. Due to this or the process, called self-purification, the ecological condition of the river is improved.

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