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Bacteriological composition of groundwater and its role in human health

Momina Javaid [a], Hawa Qasim [b], Hafiza Zobia Zia [c], Muhammad Amjad Bashir [d,*], Asma Qayyoom(e) Syeda Amber Hameed [e], Khizar Samiullah [e], Mohamed Hashem [f,g], Kareem Morsy [f,h], Saad Bin Dajem [f], Taj Muhammad [i], Musarrat Shaheen [i], Muhammad Yousaf Ali [j], Muzaffar Saeed [j], Abdulrahman Alasmari [k,l], Mohammed Ali Alshehri [k,l]

[a] Women Medical Officer BHU Rangeel Pur, Lahore, Punjab, Pakistan
[b] Women Medical Officer BHU BHU HEIR, Lahore, Punjab, Pakistan
[c] Women Medical Officer RHC 148/EB, Burewala Vehari, Punjab, Pakistan
[d] Department of Plant Protection Faculty of Agricultural Sciences, Ghazi University, Dera Ghazi Khan, Punjab, Pakistan
[e] Department of Zoology Faculty of Sciences, Ghazi University, Dera Ghazi Khan, Punjab, Pakistan
[f] Biology Department, College of Science, King Khalid University, Abha, Saudi Arabia
[g] Assiut University, Faculty of Science, Botany and Microbiology Department, Assiut, 71516, Egypt
[h] Zoology Department, Faculty of Science, Cairo University, Cairo, Egypt
[i] Cotton Research Institute, Khanpur, Punjab, Pakistan
[j] Rural Education and Economic Development Society (REEDS), Pakistan
[k] Genome and Biotechnology Unit, Faculty of Sciences, University of Tabuk, Tabuk, Saudi Arabia
[l] Department of Biology, Faculty of Sciences, University of Tabuk, Tabuk, Saudi Arabia

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ABSTRACT

Drinking water that is secure to drink is a basic human need that should be met by everyone. Waterborne disease prevention and control begin with ensuring the safety of drinking water. The present study was designed to evaluate the bacteriological quality of ground water in twenty different localities of Tehsil Taunsa DG Khan, Punjab Pakistan. For this purpose, ground water samples were collected from Mangrotha, Sokar, BastiBuzdar, KotQaisrani, JhokeBodo, Litra, Vehova, Bohar, MakwalKalan, Bindi, Dona, NariJanubi, TibbiQaisrani, Morejhangi, Babbi, Nutkani, JaluWali, Lakhani, Kotani and Chulani and bacteriologically characterized. The results revealed a significant increase in bacterial counts. Bacterial infections such as Fecal Coliforms and E.Coli had extraordinarily high concentrations, ranging from 25 CFU/mL to 50 CFU/mL and 2.5 CFU/mL to 3.5 CFU/mL, respectively. The levels of all other parameters were within WHO's acceptable ranges. A survey was also done to assess the impact of drinking water on city inhabitants' fitness. Globally, 780 million people, and 100 million people in Pakistan are exposed to insecure water sources. To estimate the health threat of infected water, a total of 160 residents interviewed. The information acquired from this field work will reveal a high prevalence of suspected water borne diseases like diarrhea, nausea & vomiting, gastrointestinal issues, Skin Rash, Skin irritation, Diabetes, Neural diseases, Renal dysfunction, Cholera, malaria, prolonged fever, Cancer, Hepatitis and jaundice. To resolve water and environmental problems, consciousness and regular monitoring programs of water organization and safe removal of waste was proposed. As a result, in all of the research areas, a well-organized waste disposal and management system is required. To make sure that the water is suitable for human consumption, regular drinking water quality assessments of the resource, main allotment tanks, distribution systems and pipes should be used.

1. Introduction

Water is necessary to survive. All creatures must have accessibility to a substantial amount of clean drinking water. This is a substance with a wide range of characteristics that is utilized in almost every sphere of life. At times, water may be the ultimate sink for a pollutant. Coastlines, streams, glaciers, pools, mountainous streams, and private water reservoirs can all be found all over

* Corresponding authors.
E-mail address: abashir@gudgk.edu.pk (M.A. Bashir).
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the world. Most water reservoirs aren't really endless; rather, their holding capacity is limited, and they renew through natural processes. Due to a variety of circumstances, all of the aforementioned natural water sources are dwindling at an alarming rate. Water scarcity in living things can have a negative impact on their nature.

In Pakistan, water contamination is some of the most serious hazards to communal life. The quality of the intake water is not properly maintained or checked. In terms of drinking water superiority, Pakistan is placed 80th out of 122 countries. Coliforms have been found in drinking water sources across the country, as well as surface and groundwater. A variety of WHO drinking water quality criteria are broken down on a regular basis. The major causes foremost to the decline of water quality are human actions such as inappropriate removal of municipal and manufacturing effluents plus indiscriminate application of agrochemicals in agriculture. Microbial impurities are the primary causes of different public health issues, either alone or in combination.

"Hepatitis B and C are significantly supplementary dangerous viral infections than corona virus infectivity, causing 300–325 deaths every day in Pakistan, but Covid-19 is causing outlying fewer deaths than viral hepatitis. The presence of a huge number of quacks, according to PMA, is the major cause for the rising number of hepatitis C cases in Pakistan." Bacterial pollutants have contaminated 89 percent of groundwater across the country. In rural locations, bacterial contamination is more prevalent. The entire expenses of healthcare due to inadequate cleanliness, dirty water, missed work time owing to water-related sickness, and early death are three times more than the combined costs of water scarcity, salinity, and flood damage. Pakistan can enhance not only the health of its inhabitants, but also the health of its economy, by enhancing the quality of its water.

Pakistan is the world's third-most water-scarce country, according to the International Monetary Fund (IMF). Excessive water use, a lack of water storage techniques, evaporating lakes, lowering water tables, population explosion, and seasonal variations are all causes that contribute to water scarcity. As a result, there is no national water strategy, and the major cause of water scarcity is the nuclear-armed confrontation between Pakistan and India, as well as the interests of the federal and local governments. Deforestation and the potential for glacier assets to be harmed. Pakistan's forest cover is shrinking at a rate of approximately 2% each year. If current trends continue, Pakistan's forests will be depleted in the next 50 years (Randhawa et al., 2017).

Water is a vital element that makes up 3% of the earth's surface. Only a small portion of this total, roughly 1.1 percent, exists for creature utilization (Hinrichsen and Tacio, 2002).According to estimates, l.1 billion citizens do not have way to protected drinking water, 2.5 billion citizens do not have adequate cleanliness and 5 million people die each year on average from waterborne infection, ten times the digit of people killed in conflicts. Even if there is enough or plenty of water, contaminants and rising demand pose a serious threat.

The impact of contaminated water on underground water is prejudiced through a figure of factors, including the depth of the water table, soil conditions, and wastewater quality. In wet areas with low fresh water tables, wastewater irrigation has a substantial impact on groundwater quality (Hussain et al., 2001).A study of groundwater quality in Faisalabad using several methodologies (graphical plotting, logarithmic nomography, trilinear charting) showed that groundwater in the city was not suitable for direct residential, agricultural, or commercial usage. Groundwater pollution is mostly caused by an increase in industrial and home waste (Hassan and Bhutta, 1997).

Faisalabad, Pakistan's most populous city requires around 64.7 million gallons of consumption water per day to meet its requirements. However, residential pumps that draw water from subsoil water and tube wells were responsible for 3 million gallons of this water (Bashir et al., 1999).Drinking water pollution is responsible for 20–40% of the entire infections within the country, resulting in yearly general financial victims of Rs 25–58 billion. Water contamination inside the country is mostly caused by unacceptable dumping of manufacturing and metropolitan wastes, followed by cross-contamination caused by outdated as well as leaking pipes and a be short of water filtering and disinfection services. Urgent situation actions are required to prevent prospect degradation of water quality and to get better existing water quality in order to defend the people from waterborne diseases.

Water contamination is also caused by a lack of qualified personnel, poor quality monitoring and an inadequate and contaminated water supply. Natural sources as well as a variety of human activities can contaminate ground water. Ground water quality can be influenced by residential, municipal, commercial, industrial and agricultural operations. Contaminants can enter ground water through actions on the ground surface, such as releases or spills from stored manufacturing wastes; sources underneath the land surface other than on top of the water table, such as infected systems or leaking subversive petroleum cargo space systems and structures under the water table, such as wells. Pakistan's current water supply is around 79 percent (Chilton, 2000).

Groundwater is a vital supply of fresh water for irrigation and drinking, thus managing its availability and quality is critical. Groundwater might be contaminated chemically, bodily, or microbiologically. Everyone is connected to a variety of sources as well as health-related issues as well as effects. A combination of microbiological and physicochemical contamination is currently threatening the quality of groundwater, which is a major supply of drinking water (Pedley and Howard, 1997; Reid et al., 2003).

Diarrhea is caused in huge fraction by faces pollution of ground water. Every day, an predictable 2,000 children under the period of five expire from diarrheal infections around the world. Approximately 90% of diarrheal sickness deaths in kids are caused by dirty water, a lack of cleanliness, or poor sanitation. Countless others, including older children and adults, suffer from ill health and missed opportunities for job and education for every youngster who dies. The most basic source of supply in the most Pakistani cities is ground water, which carries a variety of pathogens, together with several viral, bacterial as well as protozoan agents, resulting in 2.5 million fatalities each year from prevalent diarrheal infection (Kosek et al., 2003). As a result, potable water is water that is free of disease-causing microbes and potentially harmful chemical compounds.

Microorganisms as of human or animal excreta are the most common cause of microbiological contamination, which reach humans through infected groundwater from wastewater, landfills, or waste-water treatment plants, creating major fitness concerns. According to the United Nations, diarrhoea accounts meant for 80% of all infections and one-third of all fatalities in impoverished nations, and is caused by patients consuming infected water (Gasana et al., 2002; Al-Khatib et al., 2003). The majority of gastrointestinal infections that can be spread through drinking water are spread via the fecal–oral route. As a result, improvements in groundwater quality had an impact on the fight aligned with widespread diseases like typhoid and cholera in adults, as well as diarrhoea in children (Al-Khatib and Orabi, 2004). Bad water superiority is supposed to be accountable for Thirty percent of all diseases and Forty percent of all fatalities in Pakistan. Diarrhea, a waterborne disease, is the main reason of mortality in Pakistani newborns and children, with each fifth resident suffering from sickness or disease brought on by contaminated water. The groundwater supply is the primary cause of declining water quality. Each year, around one hundred million diarrheal illnesses are reported in Pakistan.

There are only a few enterprises in Pakistan that have their own wastewater treatment facilities. According to the NEQS under the 1997 Act, the government must take rigorous measures for their industrial sewage disposal. If a business is proven to be breaking the rules, it should be fined heavily and imprisoned.

To address the importance of safe drinking water, public consciousness initiatives should be launched at the school, college, university plus society levels. NGOs may have a role in this area. Rural areas should implement safe water storage control measures as well as basic drinking water treatment technologies.

Many studies demonstrate that drinking water that has been boiled lessens the chance of contracting waterborne infections. Toba-Tek Singh, Multan and Rawalpindi are three districts in Punjab's urban and rural areas where a study was done. A multistage sampling procedure was used to acquire all of the samples. The findings revealed that 45.1 percent of the populace in these 3 districts was not following National Quality Standards to enhance water quality, and that these people were experiencing diarrhea. The left-over residents of these 3 areas follow National Quality Standards and have not been establish to be unwell. Families' social and economic circumstances also play an important impact in reducing diarrheal illness. It's also been discovered that the mother's schooling, household wages and lifestyle are all linked to the superiority of drinking water and, as a result, the family's fitness.

2. Material and methods

The purpose of this research was to investigate the bacteriological composition of Ground water of Tehsil Taunsa, DG Khan, Punjab, Pakistan. For this purpose 20 water specimens were collected from 20 union councils of Tehsil Taunsa and a survey was done by interviewing 160 residents of Tehsil Taunsa in order to investigate the people perception knowledge about role of water in human health in Tehsil Taunsa, DG Khan, Punjab, Pakistan.

2.1. Location

The study was conducted in different localities of Tehsil Taunsa, DG Khan, Punjab, Pakistan.

2.2. Sample collection

Twenty ground water sites were selected in Tehsil Taunsa, DG Khan, Punjab, Pakistan for water sampling. Following the aseptic conditions, samples were collected in sterile polypropylene plastic bottles. All specimens were strongly preserved and directly taken to the laboratory for investigation. The time between sampling and examination was not more than 6 h. All specimens were Physically, chemically and bacteriologically analyzed.

3. Experimental design

Experimental work was divided mainly into two phases.

- In Phase 1 ground water samples were analyzed bacteriologically. For bacteriological investigation, samples were analyzed in term of MPN (Most Probable Number) Test and CFU (Colony Forming Unit) Test according to the standard methods (APHA, 2005).
- In phase II, a survey study was conducted to generate susceptible diseases profile of almost 160 residents of Tehsil Taunsa. For survey study a questionnaire was conducted.

4. Results

This chapter presents the results of 20 different water samples collected from 20 Union Councils in Tehsil Taunsa, as well as graphical representations of each sample value.

4.1. Bacteriological analysis

4.1.1. T. Coliforms

Total coliforms have been selected as important indicators for the presence of pathogenic microorganisms in drinking water. This is an important indication of the adequacy of drinking water. If a large number of coliforms are found in the water, other pathogenic bacteria or organisms are more likely to be present. The WHO guidelines require that there be no complete coliforms in the supply of public drinking water.

4.1.2. F. Coliforms

The presence of fecal coliforms in drinking water samples usually indicates recent fecal contamination, which means that there is a higher risk of pathogens than detecting total coliforms alone. Escherichia coli is a subgroup of fecal coliforms. The WHO guidelines require the absence of fecal coliform in public drinking water supplies. All drinking water samples collected from Taunsa Sharif were analyzed for fecal coliform bacteria and in the result all samples are showing exceed values. Highest desirable value of Fecal Coliforms is 0/100 ml. The values of Fecal coliforms in the sampling areas (Mangrotha, Sokar, BastiBuzdar, KotQaisrani, JhokeBodo,

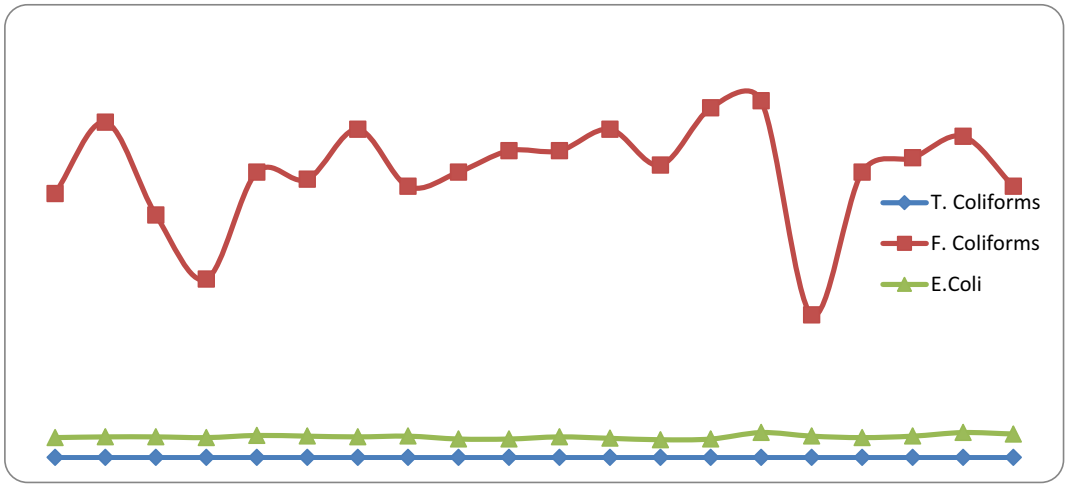

Fig. 1. Scattered graph showing the values of T. Coliforms, F. Coliforms and E. coli (in standard units) in the drinking water of the different locations of study Areas.

Litra, Vehova, Bohar, MakwalKalan, Bindi, Dona, NariJanubi, TibbiQaisrani, MoreJhangi, Babbi, Nutkani, JaluWali, Lakhani, Kotani and Chulani) were respectively 37, 47, 34, 25, 40, 39, 46, 38, 40, 43, 43, 46, 41, 49, 50, 20, 40, 42, 45 and 38. The highest value of fecal coliforms is shown in Babbi. The main sources of fecal coliform in freshwater are effluents from wastewater treatment plants, inefficient septic tank systems and animal manure. Diseases and conditions that can be affected by high fecal California count in water include typhoid fever, hepatitis, gastrointestinal, dysentery and ear infections.

4.1.3. E. coli

Escherichia coli is harmless and is present in the intestines of humans and warm-blooded animals. The presence of E. coli in drinking water samples usually indicates recent fecal contamination. This means that there is a higher risk of pathogens. The permissible limit of E. coli is 2.2 cfu. All drinking water samples collected from Taunsa Sharif were analyzed for fecal E. coli bacteria and in the result all samples are showing exceed values. The values of E. coli ranges between 2.5 and 3.5 cfu. Highest value is seen in SastiBasti. The values of E.coli in the sampling areas (Mangrotha, Sokar, BastiBuzdar, KotQaisrani, JhokeBodo, Litra, Vehova, Bohar, MakwalKalan, Bindi, Dona, NariJanubi, TibbiQaisrani, MoreJhangi, Babbi, Nutkani, JaluWali, Lakhani, Kotani and Chulani) were respectively 2.8, 2.9, 2.9, 2.8, 3.1, 3, 2.9, 3, 2.6, 2.6, 2.9, 2.7, 2.5, 2.6, 3.5, 3, 2.8, 3, 3.5 and 3.3. The highest value of fecal coliforms is shown in Nizam Abad. E. coli can cause meningitis, sepsis, urinary tract infections and other diseases.

Fig. 1 shows that the measured values of T. Coliforms were within the permissible limits of WHO, but the values of F. Coliforms and E. coli exceed the permissible limits of WHO.

5. Discussion

The majority (64.8%) of the samples were found to have high Fecal Coliforms and E.coli counts. This finding was lower than a study in Bahir Dar city which reported 77.1% of samples with high TCs count (Tabor et al., 2011) and a study in Nigeria which reported 100% of the water samples harbor coliforms in figures larger than the mandatory WHO values for drinking water (Okonko et al., 2008). This difference might be explained by the difference in water source types involved and point of water sampling in the study. The average count of FCs and E.coli in the present study was 40.15 which were above the WHO and Ethiopian standards recommended value of 0/100 ml (WHO, 1997; The Federal Democratic Republic of Ethiopia Ministry of Water Resources, 2002). Similarly, a Nigerian study depicted the presence of significant TC count in most of the wells (Oluma et al., 2010).

A sufficient supply of water is required for a healthy life. The greater the number of sources, the greater the amount of water accessible. Experts (van der Hoek et al., 2001) believe that the water has a greater effect on health improvement. Health incidences related to water can be avoided by adopting measures to improve water quality. According to various studies, households that boiled their drinking water had a lower incidence of diarrheal disease (Blake et al., 1993). According to the findings, 11.9 percent of respondents improve the quality of their water supply by boiling it, even though heating is the least expensive method of removing contaminants at the domestic level and can be implemented by almost anyone, whereas other methods such as filtration and others are expensive and difficult to accommodate. Furthermore, 28.8% of consultant firms both purification as well as boiling to improve the quality of their drinking water, indicating that they were more worried about the quality of the water they consumed.

Table 1
Methods for the physical, chemical and bacteriological analysis.

Parameters	Methods	Reference Methods
Total Coliforms	MPN/mL	American Public Health Association Color Scale -9222B
Fecal Coliforms	CFU/mL	American Public Health Association Color Scale -9222 D

According to experts, the quality of drinking water was so poor that it couldn't be consumed without any precautions. In his study, (Aini et al., 2007) focused on the actions taken by families to enhance the quality of their water supply. According to studies, some homes boiled water before consuming it, while others bought water filters to enhance the quality of their drinking water. Safe drinking water is critical for human health. According to various studies, providing safe drinking water can reduce diarrhoea by 15–20% (Fritschel, 2002). It can be that most of the interviewees, 67.5 percent, were obviously conscious that poor water quality harms human health because they were now dealing with water-related difficulties. The majority of participants (86.1 percent) stated that Pakistan is now experiencing acute water shortages, according to the findings. People were well-conscious of water-related issues (Table 1).

On the other hand, just 19.4 percent of respondents were aware that poor water quality has an impact on human health in some way. No one in their family has suffered as a result of poor water quality, according to 24.4 percent of respondents. Actually, they were employing high-quality water sources such as tube wells and water filtration plants, and some of them were doing regular water quality improvement efforts.

On the other side, 67.5 percent of respondents said that their members of the family suffered as a result of poor water quality used for drinking. According to a UNICEF report, people suffering from water-borne illnesses like as gastroenteritis, typhoid, and jaundice occupy Twenty-Forty percent of hospital beds in Pakistan (Anonymous, 2006). When pressed further about the consequences they were experiencing, 23.1 percent of families said they frequently experienced abdominal/stomach cramps. The other homes, on the other hand, were rarely affected by this issue. 12.5 percent of households had loose motions/watery motions on a regular basis, whereas 51 out of 246 (20.7) had this condition only occasionally. 16.9% of households reported having problems with vomiting. People were also suffering from bloody stools and constipation.

Various studies have found that the relationship between water quality and diarrhoea differs based on the extent of availability of water, indicating that quantity of water has a larger effect on health improvement than water quality, and that availability of water is dependent on the existence or lack of a major backup system (Jensen et al., 2004; van der Hoek et al., 2001). According to the findings, more than half of the respondents, or 44.4 percent, said they were very careful of their water usage since they frequently had to deal with water shortages at home. However, a handful of them learned that wasting water was against Islamic principles, and as a result, they were extremely conscientious about water usage and avoided wasting it. Furthermore, 40.6 percent of respondents were somewhat aware of their water usage, whereas 0.6 percent was completely unaware of their water usage.

According to respondents, one of the main reasons for not being concerned about water use was the need to maintain appropriate hygiene, which could not be achieved with limited water use. Furthermore, as discussed in FGDs, ablution was one of the reasons given by respondents for using more water because individuals

typically squandered water during this activity to keep their bodies clean (paak). The necessity of conserving water in Islam was cited by 38.8% of respondents and the second most common reason was to save money on high bills (29.4%). Water is said to be the most valuable resource required by all living things. A number of passages in the Holy Quran discuss the relationship between life and water. This is clearly stated in both the Holy Quran and the Sunnah (De Chatel, 2002). Furthermore, the third most commonly cited reason was the need to conserve water resources, as Pakistan already has a severe water scarcity. A shortage of sanitation services is the world's greatest cause of sickness (UNICEF, 2007). According to the World Health Organization, increasing sanitation reduces diarrhoea morbidity by 37% (2004). Possessing a bathroom, according to experts (van der Hoek et al., 2001), is one of the risk variable for acute gastroenteritis. As a result, the toilet is a key role in improving one's health.

It is a well-known truth that washing one's hands is vital for good health. Hand washing at critical moments can help to reduce the severity of diarrheal sickness (WHO, 2004; Maccan-Markar, 2006; Curtis and Cairncross, 2003). An educated mother, who is aware of numerous drinking water issues such as hygiene and sanitation practises, which have an impact on human health, plays a critical role in educating their family. In most cultural settings, mothers are mainly responsible for overseeing of water supplies, as well as household management, sanitary conditions, cleanliness, and wellbeing, as well as the development of children in hygiene-related matters in order to understand the impact of inadequate hygiene on wellness, according to IANGWE (2004).

In terms of infant mortality, Esrey showed that parental education and the benefits of toilets as well as piped water were interdependent. Literate women protected their young children, especially in unclean areas with no or few restrooms, and with the arrival of piped water, efficient utilization of it was practiced to provide improved hygienic conditions for their newborns. In the same way, in underdeveloped countries, mother time of schooling was frequently found to be firmly associated with enhanced child well-being (Glewwe, 1999; Boadi and kuitunen, 2005).

The multivariate analysis clearly shows that households with greater wages were fewerliable to suffer than those with lower household wages. In terms of socioeconomic factors, well-educated moms are more worried about the health of their family, are more aware of the quality of their drinking water, and use efforts to enhance it.

Finally, it is concluded that the most important and contributing factors in explaining the health outcome were the Household Income, Respondent's Education, Type of Family, Source of Drinking Water and Separate Water Storage Container.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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