

Zamzam Water is Pathogen-free, Cardioprotective and Tissue-protective: Relieving the BBC Concerns

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Abstract Zamzam water is the most beloved potable water for Muslims worldwide. It originates from Zamzam well near Al-Haram mosque in Makkah, Saudi Arabia. The British Broadcasting Corporation (BBC) raised many health concerns regarding the high nitrate and arsenic contents in Zamzam water that warrants further research investigations. In this study, we investigated the presence of bacterial contamination in Zamzam water. We also examined the effects of regular exclusive Zamzam water consumption for three consecutive months on the liver and kidney functions in experimental animals. Ethical committee approval was taken for performing the study. Eighteen white albino mice were divided into three experimental groups (six mice per group): tap water group, distilled water group and Zamzam water group. All mice were sacrificed by the end of the scheduled study duration. Our data confirmed that Zamzam water is pathogen-free. Our data revealed that Zamzam water consumption for three consecutive months was quite safe for the general health, kidney function tests (serum urea and creatinine) and liver function tests (serum ALT, serum AST, serum albumin and serum globulin). All serum parameters were in their normal ranges, which were comparable to mice exclusively drinking tap water and distilled water. Serum albumin was significantly higher ($p < 0.001$) in animals drinking Zamzam water and tap water than those drinking distilled water. Zamzam water consumption for prolonged periods was quite safe with no signs of acute or chronic arsenic toxicity and resulted in normal kidney histological structure. Normal serum AST confirms that Zamzam water is cardioprotective. In other words, BBC concerns regarding high arsenic and nitrate contents may be acceptable in tap water or other types of drinking water apart from Zamzam water. This is because Zamzam water is unique in its antioxidant components that abrogate any oxidative arsenic effects and confers a lot of therapeutic benefits owing to both arsenic and the antioxidants. In conclusion, Zamzam water is cardio-protective, tissue-protective and is

promising as future therapeutic water for many ailments. Zamzam water is devoid of any bacteriological contamination. Nitrates in Zamzam water is an original constituent and not due to contamination. Same thing applies to arsenic. Zamzam water is also pathogen-free and is cardioprotective.

Keywords: *Zamzam water, kidney functions, liver functions, AST, histology, BBC concerns*

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1. Introduction

Zamzam (ZamZam) water is one of the prophetic medicine remedies that expand to include drinks, foods, cosmetics and minor surgery (Al-hijamah, wet cupping therapy of prophetic medicine) [1]. Prophetic medicine remedies are natural, available and cost-effective remedies that are still valid and astonishing in light of modern medical research. Prophetic medicine is the medical knowledge gained from the ahadith (sayings), deeds and sunnah (life style) of prophet Muhammad peace be upon him [1]. Zamzam water was confirmed to have strong antioxidant power [2] that can effectively alleviate toxins-induced oxidative stress [3]. The single most important feature that characterizes all prophetic medicine remedies is the fact that all prophetic medicine remedies are antioxidants with varying degrees of potency. This confers tissue-protective benefits, anti-inflammatory effects and antitoxic health benefits to prophetic medicine remedies [4,5].

Therapeutic drinks in prophetic medicine include oral honey, talbinah (barley powder in water and honey), Zamzam water, camel milk and camel urine [1]. Recently, camel urine is suggested to be dried (to dissipate its water content) to get the powder that can be packed into capsules for therapeutic purposes. Therapeutic benefits of camel urine were confirmed in light of its metabolomic and elemental analysis [6]. Importantly, Zamzam water received a lot of research interest in recent years after the British Broadcasting Corporation (BBC) attracted public attention to it via releasing many health concerns regarding drinking Zamzam water [7,8,9,10].

For the authors, the BBC concerns regarding Zamzam water are "mere journalistic fears" regarding the high "acceptable" arsenic and nitrate contents in Zamzam water (Figure 1A-D). Those concerns did not consider both the past history and today reality facts that confirm absence of arsenic and nitrate health hazards in those consuming Zamzam water for long periods. Till now (more than 15 years after broadcasting the earliest BBC concerns in 2005) (Figure 1A) [7,8,9,10], there is no single case report of arsenic or nitrate poisoning or related health hazards in UK inhabitants or in Saudi Arabian citizens or among Zamzam water consumers worldwide. It is now more than 1400 years since the beginning of Islam that considered Zamzam water as a remedy among other prophetic medicine remedies and no single or group arsenic or nitrate toxicity was reported. Recently, Shomar measured the average concentrations of As and NO₃ levels in Zamzam

water and confirmed the presence of arsenic and nitrates at almost three times higher than the WHO standards (27 µg L⁻¹) and 150 mg L⁻¹, respectively while the averages of Ca and K were 95 and 50 mg L⁻¹, respectively [11]. But the important in-depth fact is the presence of a large panel of mineral antioxidants in Zamzam water (e.g. strontium, selenium, magnesium....etc) [11]. Those collectively cause a strong total antioxidant power that exceeds the oxidative stress effects induced by arsenic and nitrates i.e. Zamzam water is an antioxidant therapy as all other prophetic medicine remedies.

The first BBC concern was released in 2005 and was entitled: "Warning over 'Mecca' water sales" (Figure 1A) [7] and was followed by serial reports in the next years as "Contaminated 'ZamZam' holy water from Mecca sold in UK" and reported higher than normal nitrate and arsenic contents". BBC kept releasing its concerns for many successive years following that (Figure 1A-D) [7,8,9,10]. This urged the authors to perform this study to investigate the effects of chronic Zamzam water administration on tissue functions, vitality and histology.

In this study, we investigated the effects of chronic administration of Zamzam water (for three consecutive months) on kidney function tests and liver function tests. We also investigated kidney tissues histologically to delineate any possible arsenic-induced carcinogenic or other pathological effects that can be attributed to Zamzam water.

2. Methodology

2.1. Animal Preparation

A prior ethical committee was approved and all animal procedures were done according to the ethical research guidelines. Eighteen white albino mice (80-100 g) were allocated into this study. Animals were maintained in pathogen-free conditions and animal maintenance was performed in their polypropylene cages at a temperature of 25 °C. Animals were fed per mouth using standard laboratory pellet chow diet with pathogen-free open access to water sources during the whole period of the study (three successive months).

Bacteriological study of Zamzam water Samples: Three different Zamzam water samples were collected from the drinking water containers in the prophetic masjid (in Al-Madinah) in clean autoclaved test tubes according to the standard recommendations of water sample collection as reported previously [12].

Figure 1

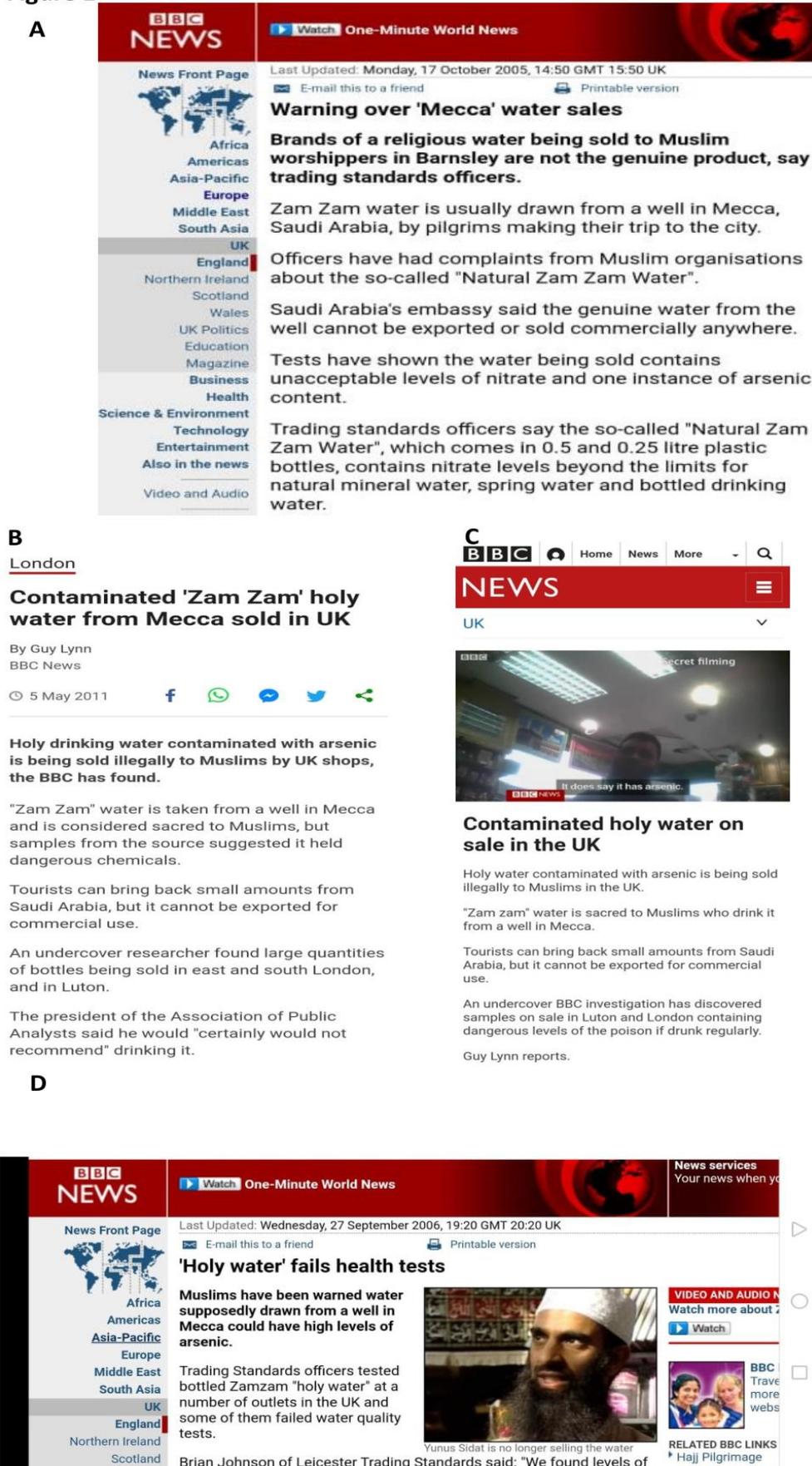


Figure 1.

Detection of water contamination: All Zamzam water samples were quite transparent and devoid of any apparent

turbidity. Centrifugation of all water samples was done. No sediment was there. To detect presence of any bacteria

in the water samples, 100 μ L of water was poured on blood agar plates to detect any bacterial growth after 24-48 hours of incubation at 37 °C. A negative control of freshly autoclaved water was used in separate plates.

2.2. Experimental Work

The major aims of the current study include investigating the effects of exclusive drinking of tap water, distilled water or Zamzam water on the liver functions, kidney functions and kidney histology to investigate

the presence of possible nephrotoxic effects due to chronic administration of Zamzam water. A prior ethical committee approval was gained before starting the experimental work. 18 mice (10 males and 8 females) were allocated into three experimental groups (6 mice per group). 18 healthy white albino mice were divided into tap water group, distilled water group and Zamzam water group. All animals were maintained at a relative humidity of 65% to 86%, and a temperature of 25 °C. Animals were assigned into four different experimental groups:

- 1st group (tap water group): received tap water for three consecutive months.
- 2nd group (distilled water group): received distilled water for three consecutive months.
- 3rd group (treated group = Zamzam water group) received Zamzam water for three consecutive months.

2.3. Biochemical Evaluation

All animals were kept in the previously mentioned experimental conditions until sacrifice. Blood was drawn into collection tubes and centrifuged to get serum. Serum liver enzymes e.g. serum glutamate pyruvate transaminase (SGPT = ALT, alanine transaminase) and serum glutamate oxaloacetate transaminase (SGOT = AST, Aspartate transaminase) were estimated using Crescent kits (Jeddah, Saudi Arabia) according to manufactures instructions.

Serum albumin assay kits (Bio Systems, Barcelona, Spain) were used. Serum creatinine assay kits (Bio Systems, Barcelona, Spain) were used. Serum globulin assay kits (Bio Systems, Barcelona, Spain) were also used.

2.4. Histological Examination of the Kidneys

The kidney specimens were collected then measured by the liquid displacement method of Scherle [13] where the organ was separated into several minor fragments kept for 48 h at room temperature in a fixative (freshly prepared 4% w/v formaldehyde in 0.1 M phosphate buffer, pH 7.2). Later, it was embedded in Paraffin (Sigma Co., St. Louis, MO, USA), sectioned at 3 μ m thickness, and the sections were stained with hematoxylin-eosin (H & E) [14]. A number of photomicrographs were taken at the indicated magnifications (100X and 400X).

2.5. Statistical Analysis

Data was collected, analyzed using SPSS software and presented as mean \pm standard error of mean. Paired samples t test was used to compare results between

experimental groups. * indicated $p < 0.05$, ** indicated $p < 0.01$ and *** indicated $p < 0.001$.

3. Results

Zamzam water has no microbial water contamination: Out of 3 Zamzam water samples, no single sample showed any growth on blood agar plates (Figure 2).

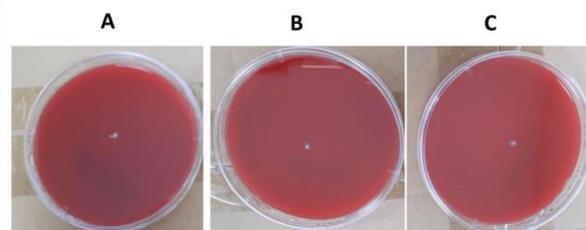


Figure 2.

Effects of chronic exclusive administration of Zamzam water on renal functions

First of all, we confirmed that chronic exclusive Zamzam water consumption (in an independent animal group for three successive months) was quite tolerable as was the other two groups dependent on distilled water and tap water only (negative control). Chronic administration of Zamzam water did not induce any apparent morbidity or health problems in all animals in this experimental group. Moreover, exclusive Zamzam water consumption for three consecutive months did not increase serum urea that was still in the normal range (20-40 mg/dl). Serum urea in mice receiving Zamzam water was comparable to mice administering distilled water and tap water. No significant differences ($p > 0.05$) were there (Figure 3A).

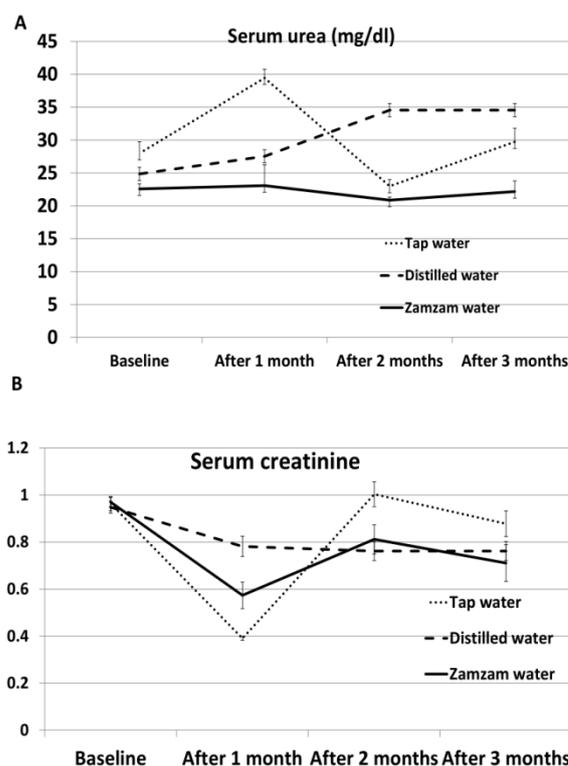


Figure 3.

Same thing was found regarding serum creatinine. Mice exclusively drinking Zamzam water as the only source of drinking water for 90 consecutive days kept a normal serum creatinine in the normal range (0.5 -1.5 mg/dl) throughout the whole experimental period. In this study, serum creatinine was less than 1 mg/dl for mice receiving exclusive Zamzam water drinking. As for mice receiving distilled water or tap water, serum creatinine levels were comparable to that and all were kept in the same normal range (Figure 3B).

Effects of prolonged exclusive Zamzam water drinking on liver function tests

Then, we investigated the effects of chronic consumption of Zamzam water on liver function tests. Zamzam water was given for three consecutive months to mice versus an experimental group that received tap water only. The last group received distilled water only for the whole experimental period. Liver function tests were estimated for all the animals. Investigated liver function tests included serum ALT (GPT), serum AST (GOT), serum albumin and serum globulin (Figure 4A-D).

Serum liver enzymes (ALT and AST) were normal for all the experimental groups throughout the whole experimental period (90 days). Serum ALT was quite normal (less than 40 U/l) for mice drinking Zamzam water, mice drinking tap water and mice drinking distilled water. No significant differences were there among all the experimental groups ($p>0.05$) (Figure 4A).

Serum AST (GOT) was going parallel to serum ALT levels. This confirms the cardioprotective effects of Zamzam water. All mice in the three experimental groups were having normal serum levels of AST (less than 40 U/l). There were no significant differences among all the mice in the three experimental conditions ($p>0.05$) (Figure 4B).

Regarding serum albumin, all mice in the three experimental conditions (drinking Zamzam water, tap water and distilled water) had normal serum albumin levels. Animals dependent on Zamzam water and tap water had significantly higher serum albumin values ($p<0.001$) compared to the other groups (Figure 4C). This may need further research investigation.

Regarding serum globulin, all mice in the three experimental conditions (drinking Zamzam water, tap water and distilled water) had normal serum globulin levels with no significant differences ($p>0.05$) from each other (Figure 4D).

3.1. Histopathological Results

The kidney of control group (CW) receiving tap water revealed preserved tissue architecture of the renal cortex where the cortical tissues exhibited normal cortical glomeruli. There were some focal, mild congestion of inter-tubular capillaries. Mild swelling of cortical tubular epithelial cells was also seen. The other two groups receiving distilled water (DW) and Zamzam water (ZW) had normal histological picture of the renal cortex. The cortical renal tubules of both proximal and distal convoluted tubules revealed intact basement membrane and intact brush border of the proximal convoluted tubules. Glomeruli were normal in all mice of the three experimental groups. Histological examination revealed

normal renal interstitium with unremarkable blood vessels (no pathological abnormality).

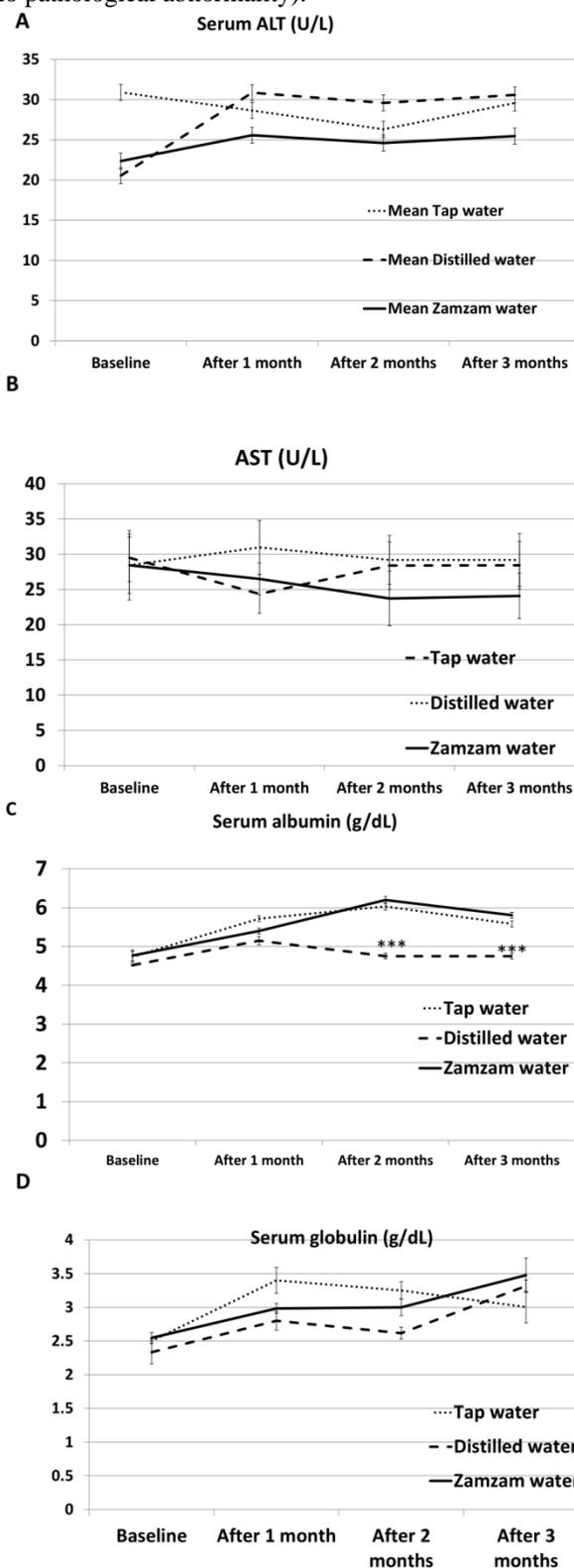


Figure 4.

4. Discussion

Zamzam water safety becomes a controversial topic after the release of many concerns published sequentially by the BBC carrying a lot of “journalistic health fears” regarding the health effects of Zamzam water [7,8,9,10]

that proved to have almost three times the average permitted levels of arsenic and nitrates [11]. This urged us to investigate the health effects of Zamzam water. The concerns raised by the BBC deserved a lot of research studies.

First of all, investigation of three Zamzam water samples collected aseptically from water tanks available for public use in the prophetic masjid in Al-Madinah Al-Munawwarah confirmed sterility and lack of any bacterial growth in Zamzam water (Figure 2). Based on that, the high nitrate content in Zamzam water is not of bacterial origin but is most likely to originate as a natural “non-harmful and may be useful” constituent of Zamzam water. Moreover, it is well-known that methemoglobinemia usually occurs due to high nitrates and afflicts infants in particular. Badar et al confirmed safety of nitrate contents in Zamzam water and total absence of the risk of methemoglobinemia in rat pups (infants) [15]. This is in line with the report by Abu taweel who confirmed total absence of teratological effects in animal embryos due to Zamzam water consumption [16]. On the contrary, Zamzam water was reported to exert tissue-protective effects via reducing the clastogenic and cytotoxic effects of gamma irradiation [17].

Mice exclusively dependent on Zamzam water for drinking did not experience any skin changes, hepatic changes or renal changes that can be attributed to arsenic effects. There were no differences in behaviour of mice drinking Zamzam water, tap water or distilled water (data not shown).

Then, we investigated the effects of drinking the three types of water (Zamzam water, tap water and distilled water) on kidney functions tests. Data of the present study confirmed that all the three types of water did not affect serum urea and creatinine (Figure 3A-B). The effects were quite normal regarding the kidney functions. Three months dependence on Zamzam water was quite safe for kidney functions. Our data relieved the BBC concerns regarding the relatively high content of arsenic in Zamzam drinking water. This can be explained by the fact that the overall antioxidant power of Zamzam water strongly antagonizes and abolishes the arsenic-induced oxidative stress. This property is in favour of normal cells that usually keep a better antioxidant system than cancer cells. The relatively high endogenous oxidative stress in cancer cells may be added to their relatively decreased antioxidant potential to render cancer cells more vulnerable to arsenic content in Zamzam water. Cancer cells are also less responsive to the antioxidant benefits conferred by the antioxidant minerals in Zamzam water. This makes Zamzam water beneficial to normal body cells and in the same time confers anticancer potential to cancer cells.

Regarding the liver function tests, serum liver enzymes (ALT and AST) were quite normal and within the normal range (<40 U/l) in all the animals drinking the three different types of water (Figure 4A-B). This confirms safety of Zamzam water to liver cells. Raised serum ALT and AST levels reflects harmful cellular damage that may disturb the integrity of hepatocytes. That is totally absent upon prolonged administration of Zamzam water. This relieves much of the concerns raised by the BBC regarding arsenic content in Zamzam water. Moreover, the synthetic power of hepatocytes (for synthesizing albumin

and globulins) is quite intact and are not disturbed by prolonged administration of any of the water types (Figure 4 C-D). There were no significant differences in serum albumin between animals drinking Zamzam water and tap water (Both at the high normal range). But, there was a significant difference between animals drinking Zamzam water and animals drinking distilled water regarding serum albumin levels ($p < 0.001$) (Figure 4C). This may be explained by the fact that distilled water is devoid of minerals. Lack of minerals may suppress the enzyme machinery for albumin synthesis.

There were no significant differences in serum globulins levels among the three experimental animal groups. Our data confirmed safety of prolonged use of Zamzam water comparable to other drinking water types regarding the metabolic and synthetic functions of the liver (Figure 4A-D). Our data relieves much of the concerns raised by the BBC regarding fears of relatively high arsenic in Zamzam water.

The relatively high Zamzam water content of arsenic is expected to have a lot of therapeutic benefits in light of the current use of arsenical compounds in the treatment of acute promyelocytic leukemia [18]. On the other hand, beneficial effects of arsenic content in Zamzam water to humans warrants a lot of research studies. That also applies to the concerns raised by BBC regarding the high nitrate content in Zamzam water that is suspected by many researchers to reflect a bacterial contamination of the water in addition to being able to induce methemoglobinemia. All these raised assumptions and concerns were excluded by many research studies (including our data in Figure 2) that followed publishing the BBC concerns.

In other words, BBC concerns regarding arsenic content may be acceptable in tap water or other types of drinking water apart from Zamzam water. This is because Zamzam water is unique in its antioxidant components that abrogate any oxidative arsenic effects and confers a lot of therapeutic benefits owing to the presence of both arsenic and the antioxidants. Zamzam water contains the pro-oxidant element arsenic at 27 $\mu\text{g/l}$ (more than twice the permitted international standard). That may confer a pro-oxidant nature to Zamzam water. However, Zamzam water contains a large panel of antioxidant metals (ion cofactors) [2,3] that confer antioxidant benefits and antagonize the pro-oxidant effects of the relatively high arsenic content. Such antioxidant minerals present in Zamzam water (but not in other drinking water sources) include selenium, manganese, magnesium, strontium and others. Collectively, the antioxidant potential of Zamzam water is strong [2,3] and is far stronger than the pro-oxidant effects added by arsenic.

Regarding the 1^{st-3rd} concerns (Table 1), we agree that Zamzam water contains high “but acceptable” levels of arsenic and nitrate as they are totally opposed by the strong antioxidant power of the other contents of zamzam water (e.g. selenium and strontium). This is supported by our data (Figure 3-Figure 5). Persistence of same levels of arsenic and nitrates in successive measurements of water samples [11] confirms that both are constituents and there is no contamination. Prohibiting drinking Zamzam water is not accepted till proving any possible harm through evidence-based research but not journalistic concerns.

Zamzam water is not poisonous but it is quite safe. This is confirmed by our data (Figure 2-Figure 5) in this study and by other previously reported data [15,16,17]. BBC is strongly asked to provide any research study to support its concerns or to withdraw the concerns with public notification.

Table 1. Some BBC concerns regarding Zamzam water [7,8,9,10]

- 1) Zamzam water contains high unacceptable levels of arsenic and nitrates (Figure 1A) [7].
- 2) Association of Public Analysts did not recommend drinking ZamZam water (Figure 1B) [8].
- 3) President of the British Association of Public Analysts considered Zamzam water a poisonous drink(Figure 1B) [8].
- 4) Secret recordings captured the vendors describing customers who drank ZamZam water daily(Figure 1B) [8].
- 5) The Food Standards Agency said people "should consider avoiding" the drink (ZamZam water) in the UK(Figure 1B) [8].
- 6) BBC investigation of ZamZam water:
 - a) showed high levels of nitrate (may reflectpotentially harmful bacteria).
 - b) traces of arsenic at three times the permitted maximum level
 - c) is similar to the illegal water which was purchased in the UK.
- 7) ZamZam water may be contaminated with arsenic and nitrates. (Figure 1B) [8].
- 8) "ZamZam" water is "a sensitive matter" as people see this water as a holy water" [9].
- 9) Holy water contaminated with arsenic is being sold illegally to Muslims in the UK (Figure 1C) [9].
- 10) Authorities should take an action (Figure 1C) [9].
- 11) Muslims have been warned (water supposedly drawn from a well in Mecca could have high levels of arsenic) (Figure 1D) [10].
- 12) Trading Standards officers tested bottled Zamzam "holy water" at a number of outlets in the UK and some of them failed water quality tests due to high nitrates and arsenic (Figure 1D) [10].
- 13) Some shops in UK stopped selling the water for fear of genuine nature and contents (Figure 1D) [10].
- 14) Leicester Trading Standards said: "Arsenic can cause cancer if consumed over a long period of time and nitrates can cause heart problems" (Figure 1D) [10].

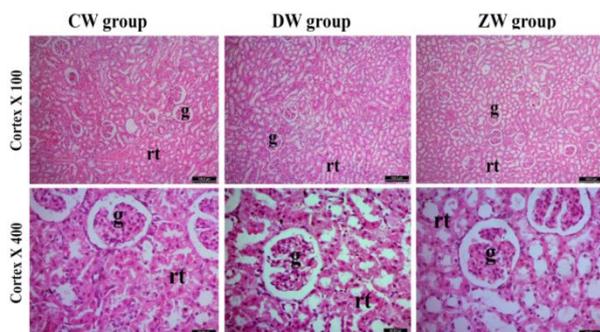


Figure 5.

Regarding the 4th-7th concerns (Table 1), the BBC reported that the secret recordings captured the vendors describing customers who drank ZamZam water daily. The BBC did not comment on the health status of those who kept drinking Zamzam water daily: Did they acquire any health harms due to chronic drinking of Zamzam water that has high arsenic and nitrate? Absence of any comment from the BBC in this respect confirms that no health harm was there to support the BBC concerns. The BBC did not report any single case morbidity or fatality that can accuse Zamzam water consumption. Comments on that are quite professional and should be addressed.

Regarding the 8th -14th health concerns, health authorities are requested to listen to evidence-based medical research studies rather than journalistic expectations. As long as no case morbidity was attributed to Zamzam water, no need

to frighten the public or to warn against Zamzam water. Drinking Zamzam water occurs continuously since old ages to present. What is the trigger to raise such health concerns now? We agree this is a sensitive matter but unfortunately, it was raised in a non-scientific manner and the BBC is requested to revise that. We do confirm that all components of Zamzam water are balanced i.e. high arsenic and nitrates-induced oxidative stress is balanced by the high antioxidants strontium, selenium, magnesium, zinc and the alkaline pH. It is well-accepted that natural alkaline drinking water is very rare globally and this is a great merit in Zamzam water being a natural alkaline water.

Interestingly, Zamzam water exhibited potent anticancer effects against human breast cancer cells [19] and human lung cancer cells [20].

In conclusion, Zamzam water research is an interesting subject of nutritional and public health research owing to the high minerals content.

5. Conclusion

Zamzam water is devoid of any bacteriological contamination. Nitrates in Zamzam water is an original constituent and not due to contamination. Same thing applies to arsenic. Zamzam water is pathogen-free and is cardioprotective. Chronic administration of Zamzam water was quite safe to tissue structure and functions. Many research articles confirmed that Zamzam water is tissue-protective and exerts anticancer effects. So, no worry should be addressed about any carcinogenic possibility that can be attributed to it. BBC is strongly encouraged to revise its concerns and to notify that to the public.

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