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Analysis of Biological and Chemical Parameters in Alkaline Water of Various Brands in Indonesia

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ABSTRACT Humans need drinking water in life and up to 70% of the human body is water. Consuming enough mineral water for the body can help the process to facilitate digestion, regulate metabolism, regulate food substances in the body and regulate body balance. 46.1% of adolescents from 1200 respondents studied when feeling thirsty prefer instant drinks compared to consuming mineral water, this causes mild dehydration with symptoms: dry lips up to the throat, body weakness. This study aimed to analyze the levels of biological and chemical parameters in alkaline water of various brands in Surabaya which were coded KW, M, P and T. This study was experimental with a post-test only control group design. The research data were statistically tested using one-way ANOVA with the aim of analyzing the levels of biological (E.Coli and MPN Coliform) and chemical (arsenic, fluoride and total chromium) parameters in alkaline water (KW, M, P, T). E.coli parameters in 4 types of alkaline water which were coded KW, M, P and T met the standard requirements, namely 0 colonies/100 ml. Chemical parameters namely arsenic met the requirements of 0-0.1 ppm, fluoride met the requirements of 0.01-1.5 ppm and total chromium met the requirements of 0.01-0.05 ppm. In accordance with the results of the examination, it is revealed that the process of making and producing alkaline water of various brands in the market under study are following the Good Food Production Methods (CPPB), thus there is no E. Coli and MPN Coliform content. Suggestions can be given to future researchers and the community; future researchers need to conduct further research on other brands of alkaline water in various areas with a wider range while the community needs to be more selective and smart in choosing alkaline water to be consumed to maintain a healthy body so they can benefit it at an affordable price.

INDEX TERMS Alkaline Water, Parameters, Microbiology, Biology.

I. INTRODUCTION

Humans need a source of energy in everyday life, namely through eating and drinking. To fulfill it, humans have the need for drinking water. Up to 70% of the human body is fluids (water). Humans really need an adequate supply of water to maintain freshness, physical fitness and balance acid-base regulation for metabolic processes in the body. Drinking water, especially those containing minerals that meet the standard requirements, namely nutritional elements that are as important as carbohydrates, proteins, fats and vitamins are needed. Humans need mineral water to meet the needs of body fluids as much as 1-2,5 liters or the equivalent of an estimated 6-8 glasses every day. Alkaline water with minerals content that meets the standard requirements, if consumed every day in accordance with the requirements, can help the process of facilitating digestion, regulating metabolism, regulating food substances in the body and regulating body balance[1][2].

46.1% of adolescents from 1200 respondents studied when feeling thirsty prefer instant drinks compared to consuming mineral water, this causes mild dehydration with symptoms: dry lips up to the throat, body weakness[3].

Other symptoms that are more severe if the body experiences a lack of water intake, namely the blood will thicken so that you feel excessively tired, lethargic, and often sleepy. This is because the fluid in the blood is sucked in for other needs in the body. Losing 4-6 percent of water causes the body to experience headaches, fatigue, weakness[4]. If the lack of water reaches 12 percent, the function of movement or body muscles can be disrupted. Lack of 15-25 percent of body fluids is fatal to the human body. In addition, lack of water can cause kidney problems, such as kidney stones and urinary tract infections. So that everyone is encouraged to drink enough water, according to one of the messages of the Balanced Nutrition Guidelines from the Ministry of Health[5][6]. Humans are exposed to pollutants every day, including those from motor vehicles, cigarette smoke, cosmetics, food additives and food preservatives, etc. Pollutants produced from human activities include SOx, NOx, Pb, Hg, COx, formaldehyde, benzene, NH3, O3, etc. The health impacts

caused by exposure to air pollutants lead to respiratory tract irritation, fibrosis and lung cancer. Likewise, consuming too many foods that contain food preservatives, additives, dyes, etc. leads to health problems, especially those related to digestive system disorders, kidney and liver functions[6].

Any toxicant that enters the body will affect the condition of body fluids, especially the blood pH; the more toxicants enter the body, the more acidic the blood pH will become[7][8]. Blood and body tissues require alkaline conditions to maintain balance in the body's metabolic processes; one effort that can be made to determine the blood pH is by testing the pH of the urine using a pH strip, or litmus paper. Blood is said to be in a good alkaline condition if it is with a pH of 7.365 so the urine pH is around 7.2-7.5. When the blood pH is below 7, it indicates the level of acidity in blood that can damage all organs in the body. Usually, those with cancer are found with the pH in their bodies at 4.5 or 5 which is relatively acidic because the cancer virus continues to grow uncontrollably causing the body's immune to decrease and the blood in producing red blood cells to become less than optimal to fight cancer cells in the body[9].

An effort that can be made to detoxify and neutralize toxicants in the body is by consuming alkaline water; alkaline water is water that has a pH> 8 which aims to neutralize toxicants that enter the body[10].

Alkaline water refers to the electrolysis of water produced from minerals such as magnesium and calcium, in the presence of a very high elemental hydrogen content, high pH and negative oxidation-reduction potential. This hydrogen rich water has been introduced as a possible therapeutic strategy for health promotion and disease prevention. Water with high hydrogen is able to clean ROS, protect DNA from oxidative damage and stimulate metabolism[11].

The minerals contained in alkaline water include calcium, magnesium, sodium and potassium. The functions of minerals in the body are to produce enzymes, control osmotic pressure in the body, form soft and hard tissue structures, maintain healthy bones and teeth, help the formation of body antibodies, help muscle contraction and accelerate nerve responses, prevent pain in muscles, control the balance of water and acid-base levels in the blood, maintain brain function, distribute oxygen throughout the body and maintain healthy heart and nerves[9].

Based on data from the Industry and Trade Office of Surabaya, the sale of alkaline water in Surabaya during 2018-2019 was dominated by the brands of millagross, pristine, total-8+ and Eternal Plus (E+). The alkaline water must meet the standards of the Minister of Industry No.78/M-IND/PER/11/2016 concerning the Compulsory Enforcement of SNI for Mineral Water, Demineralized Water, Mineral Water, and Dew Drinking Water, microbiological quality in the form of E.Coli and MPN Coliform 0/100 ml, physical quality in the form of TDS maximum limit of 500 ppm, and chemical quality in the form of pH 8-9[10][11].

This study aimed to analyze the levels of biological and chemical parameters in alkaline water of various brands in Surabaya which were coded KW, M, P and T.

II. METHODS

A. MATERIALS

The type of research used was experimental with a post-test only control group design because the researchers want to compare the microbiological and chemical quality of various types and brands of alkaline water including (alkaline water from KW machine, P, M and T brands).

B. OBJECT OF STUDY

The objects in this study were microbiological (E.coli and MPN Coliform) and chemical (arsenic, total chromium) parameters on various types and brands of alkaline water including (alkaline water from KW machine, P, M and T brands).

C. PROCEDURES

The steps taken in this study include:

1. List all types of alkaline water circulating in Indonesia. That is of alkaline water circulating in Indonesia is as many as 15 trademarks.
2. Identifying alkaline water brands in Indonesia, which were selected as many as 4 brands and coded (KW, M, P, T)
3. Preparing alkaline water from the machine to be used as a sample and examined in the laboratory
4. After all alkaline water were available, taking as many as 5 samples on each brand coded with (KW, M, P, T)
5. Checking alkaline water content with microbiological (E.coli and MPN Coliform) and chemical (arsenic, total chromium) parameters on each brand of alkaline water coded with (KW, M, P, T) at the Laboratory.

D. DATA COLLECTION

The examination was carried out to determine the concentration of microbiological parameters (E.coli and MPN Coliform) and chemical (arsenic and chromium) of various types and brands of alkaline water including alkaline water (KW, M, P, and T).

E. STATISTIC ANALYSIS

The data obtained were presented in the form of tables and descriptive, then analyzed using statistical tests, with $\alpha = 0.05$. The results of data processing through statistical tests were used to draw conclusions. The statistical test used was one-way ANOVA to compare microbiological (E.coli and MPN Coliform) and chemical (arsenic, total chromium) parameters of various types and brands of alkaline water including (alkaline water from KW machine, P, M and T brands).

III. RESULT

Based on the study that has been carried out by comparing the microbiological and chemical quality of alkaline water from various brands on the market, the results are presented as follows:

A. MICROBIOLOGICAL PARAMETERS

In this study, the biological parameters of alkaline water examined were E.Coli and MPN Coliform parameters—which results can be seen in TABLE 1 which aims to describe the biological content of alkaline water from various brands on the market, the results are presented as follows:

TABLE 1
Average Results of Alkaline Water Microbiological parameters

No	Parameter	Unit	Standard	KW	M	P	T
1	E. coli	col/100 ml	0	0	0	0	0
2	MPN Coli	col/100 ml	0	0	0	0	0

Based on TABLE 1, it can be seen that E.Coli and MPN Coliform parameters in 4 types of alkaline water which were coded KW, M, P and T met the standard requirements, namely 0 colonies/100 ml.

B. CHEMICAL PARAMETERS

The chemical content of alkaline water examined was the mineral water parameters (arsenic, fluoride and total chromium) which aims to describe the chemical content of alkaline water from various brands on the market, the results can be seen in Figure 1.

Based on the data in the following Figure 1, it can be seen that chemical parameters, namely first, arsenic met the requirements of 0-0.1 ppm, namely for KW code was 0.05 ppm, M code 0 was ppm, P code 0.002 was ppm and T code was 0.003 ppm. Then, fluoride also met the requirements of 0.01-1.5 ppm, namely for KW code was 0.005 ppm, M code was 0.003 ppm, P code was 0.0025 ppm and T code was 0.0025 ppm. Finally, total chromium concentration was in the eligible category of 0.01-0.05 ppm and met the requirements with the following details, namely for KW code was 0,245 ppm, M code was 0,25 ppm, P code was 0,19 ppm and T code was 0,17 ppm following the Regulation of Minister of Industry No.78/M-IND/PER/11/2016 concerning the Compulsory Enforcement of SNI for Mineral Water, Demineralized Water, Mineral Water, and Dew Drinking Water[12].

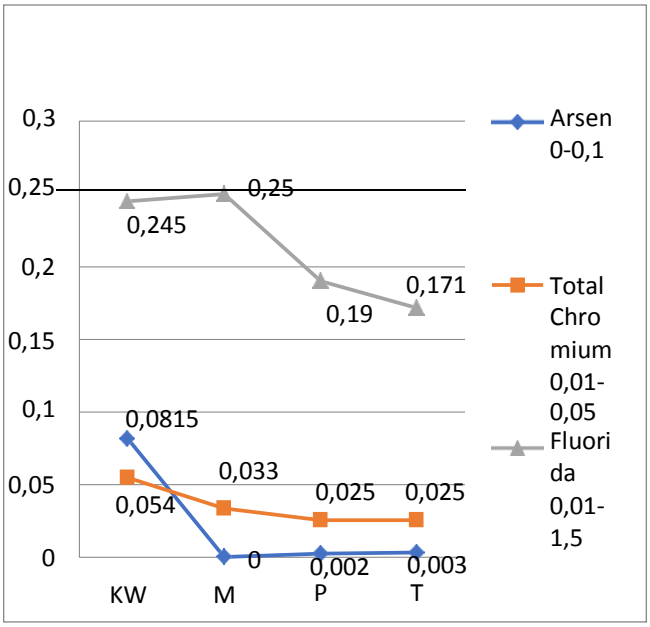

FIGURE 1. Chemical Parameter Levels in Alkaline Water

C. STATISTIC ANALYSIS

TABLE 2 explains the results of laboratory tests that were analyzed using one-way ANOVA. The purpose of the statistical analysis in this study was to determine the differences in biological and chemical qualities (parameters) of alkaline water from various brands on the market. The results of the analysis of differences in biological and chemical qualities of alkaline water from various brands are presented in the following table:

TABLE 2
Analysis of Differences in Microbiological and Chemical Quality of Alkaline Water from Various Brands

Parameter	F	p
E.Coli	3.21	.00*
MPN Coliform	2.21	.00*
Arsenic	26.867	,004*
fluoride	25.814	,004*
Total Chromium	2,444	,204

* $p < 0.05$ (significant)

Based on the statistical in TABLE 2, it can be seen that the variables that have a significance of $p<0.05$ are TDS, E.Coli, MPN Coliform, pH, DO, Arsenic, Fluoride, Cadmium, nitrite, nitrate, cyanide and selenium which indicate that there are differences in concentrations in those parameters. The difference in the concentration of minerals

content is influenced by the surrounding environmental conditions[13]. Mountain springs are naturally formed from rainwater that infiltrates into the system of volcanic rock layers due to gravity. On its way through volcanic rock layers, the rainwater is filtered and naturally absorbs minerals that are essential for the human body, such as calcium, sodium, magnesium and potassium. This natural process produces water with naturally balanced minerals content[14].

IV. DISCUSSION

A. MICROBIOLOGICAL PARAMETERS

In accordance with the results of the examination above, it can be seen that the process of making and producing alkaline water of various brands in the market under study have been processed properly following the Good Food Production Methods (CPPB), so alkaline water is free from

E. the presence of coliform contamination coming from the feces of humans and warm-blooded animals contained in septic tanks. Septic tank leaks are the cause of contamination of groundwater with coliforms and E. Coli[7].

E.coli in the open-air live in the soil. E.coli and coliform bacteria arise due to pollution (generally organic pollutants characterized by high BOD concentrations), where the soil media is a good growth site for these bacteria and causes an increase in the concentration of E. coli in the soil. When it rains or snow melts, more of these bacteria are carried by groundwater into rivers[3].

The presence of E. coli will be detected in groundwater and rivers, thus indicating an indicator of soil contamination by E. Coli bacteria. E.coli bacteria cannot be killed by freezing; these bacteria can only be killed by antibiotics, Ultraviolet (UV) light, or high temperatures>1000 C. Temperatures >1000 C will damage the proteins in cells and make them unable to live again. E.coli is a bacterium that cannot be genetically engineered (wild type) and generally cannot survive on antibiotics such as amphicillin and chloramphenicol[15].Antibiotics such as Amoxicillin are sufficient (a derivative of amphiccillin which is lower in killing power) [16].Coli and MP N Coliform bacteria. The presence of E. Coli and MPN Coliform is thought to be due to The presence of excessive E.coli can cause diarrhea, dysentery, cholera—and if these bacteria spread to other body systems/organs, it can cause infection. The presence of E. coli bacteria into the urinary tract can cause urinary tract infections (col/100 ml) [17][18].

B. CHEMICAL PARAMETERS

Based on the results described in Figure 1, it can be seen that the chemical quality parameters in all four types of alkaline water used as samples in the study met the standard requirements. This means that these alkaline water is safe and can be consumed by the public. The human body is able to balance/ do homeostasis. Homeostasis (balancing) is all processes that occur in living organisms in maintaining the internal environment so that conditions remain optimal for the body. The acid-base balance in the human body depends on the condition of the concentration of ion (H^+) which is alkaline at the pH of the blood as a body fluid [19]. Efforts to maintain body balance can be done by applying clean and healthy living behavior, applying healthy eating, doing psychological care so as not to be easily stressed, being diligent in exercising and not consuming alcohol or acidic foods and drinks such as soft drinks as well as consuming 8 liters of alkaline/ mineral water/day. The amount of body fluids in adults is approximately 45-75% of body weight; where the amount of body fluids in men is approximately 60%, in women is approximately 55% and in children is approximately 70– 80% of body weight. Water has many functions in the human body and the biggest function is to improve blood flow and promote metabolism. Water activates the life of bacteria in the intestines and enzymes; it also removes dirt and toxins, pollutants, food additives that are > 8 and is alkaline because it contains ions (OH^-)[20]. Ionized alkaline water (AAT) is water that has a high redox potential value (namely, it is a good antioxidant because it has a negative ORP (Oxydation Reduction Potential) value and the water molecule size is in the smaller category than ordinary water (micro-clustered)). All these help inhibit the spread of cancer and help kill cancer cells, directly or indirectly. If the environment of our body has changed from oxygen in an acidic environment to oxygen in an alkaline environment, viruses, bacteria and fungi cannot live. Water Ionized Alkali can prevent the occurrence of carcinogens—all of which can be flushed out of the body by consuming more alkaline water according to the requirements[19][21]. Alkaline water is a liquid or water that has a pH an acidic condition in our body and maintain our body in an alkaline environment [22].

The fluoride content is useful for rebuilding previously weakened tooth enamel, slowing the loss of minerals from tooth enamel, stopping the initial process of cavity, and preventing the growth of oral bacteria that damage teeth [23].

The chromium element within the permissible limits functions to help convert glucose in the blood into body energy, so that glucose in the blood can decrease. The chromium element also works in the body to build muscle, burn fat, and help the body utilize carbohydratest[24][25].

V. CONCLUSION

Based on the results of laboratory examination regarding the content of alkaline water (KW, M, P and T), chemical minerals (arsenic, fluoride and total chromium) and microbiological contents (E .Coli and MPN Coliform) of these alkaline water met the requirements and in accordance with the Per.Ka BPOM RI (Regulation of the Head of Food and Drug Administration of the Republic of Indonesia) No: HK.03.1.23.07.11.6664 Year 2011concerning Supervision of Food Packaging and the Regulation of Minister of Industry No.78/M IND/PER/11/2016 concerning the Compulsory Enforcement of SNI for Mineral Water, Demineralized Water, Mineral Water, and Dew Drinking water. Based on statistical tests comparing the microbiological and

chemical parameters of alkaline water from various brands on the market studied, it can be seen that all four types of alkaline water studied met the requirements.

V. ACKNOWLEDGMENTS

Suggestion that can be given following the above conclusions are as follows:For other Researchers: future researchers need to conduct further research on other brands of alkaline water in various areas with a wider range. Future researchers need to conduct further research on I-water machine on the market in order to increase public knowledge about the development of alkaline water. For the community: the community needs to be more selective and smart in choosing alkaline water to be consumed to maintain a healthy body so they can benefit it at an affordable price for the middle and lower economic class people. The community needs to be wiser in choosing alkaline water; it is preferably that they choose alkaline water with more minerals content, namely the KW code (in this study) because the minerals arsenic, fluoride and total chromium are quite high compared to alkaline water with M, P, and T codes.

REFERENCES

[1] P. Wulandari, A. Suwondo, R. Sri, and E. P. Astuti, "Utilization of Alkaline Water as An Alternative Complementary Therapy on Triglyceride Levels among Patients with Grade I Hypertension," *Int. J. Nurs. Heal. Serv.*, vol. 3, no. 6, pp. 662–671, 2020, doi: 10.35654/ijnhs.v3i6.358.

[2] T. T. Trinh *et al.*, "Development of alkaline reduced water using high-temperature-roasted mineral salt and its antioxidative effect in raw 264.7 murine macrophage cell line," *Processes*, vol. 9, no. 11, Nov. 2021, doi: 10.3390/pr9111928.

[3] K. Patel *et al.*, "ALKALINE WATER: THE DISEASE FIGHTING WATER," 2014. [Online]. Available: www.wjpr.net

[4] S. Shirahata, T. Hamasaki, and K. Teruya, "of reduced waterAdvanced research on the health benefit," *Trends Food Sci. Technol.*, vol. 23, no. 2, pp. 124–131, Feb. 2012, doi: 10.1016/j.tifs.2011.10.009.

[5] G. Sonwane, S. Bhagat, V. Borkar, S. Jain, S. khan, and M. Kale, "Pharmacological Activity Investigation of Alkaline Water – A Review," *Int. J. Pharm. Sci. Rev. Res.*, vol. 64, no. 1, pp. 88–91, Sep. 2020, doi: 10.47583/ijpsrr.2020.v64i01.017.

[6] H. Yan *et al.*, "Extension of the lifespan of caenorhabditis elegans by the use of electrolyzed reduced water," *Biosci. Biotechnol. Biochem.*, vol. 74, no. 10, pp. 2011–2015, 2010, doi: 10.1271/bbb.100250.

[7] J. Bajgai *et al.*, "Effects of Alkaline-Reduced Water on Gastrointestinal Diseases," *Processes*, vol. 10, no. 1. MDPI, Jan. 01, 2022. doi: 10.3390/pr10010087.

[8] J. Weidman, R. E. Holsworth, B. Brossman, D. J. Cho, J. St Cyr, and G. Fridman, "Effect of electrolyzed high-pH alkaline water on blood viscosity in healthy adults," *J. Int. Soc. Sports Nutr.*, vol. 13, no. 1, Nov. 2016, doi: 10.1186/s12970-016-0153-8.

[9] M. Logozzi *et al.*, "In vivo antiaging effects of alkaline water supplementation," *J. Enzyme Inhib. Med. Chem.*, vol. 35, no. 1, pp. 657–664, Jan. 2020, doi: 10.1080/14756366.2020.1733547.

[10] K. Dwi Handayani, M. N. Widyawati, T. ' Adi, and K. D. Handayani, "The Effect of Combination Alkaline Water and Iron Tablets on Improving Hemoglobin Level among Adolescent," *Int. J. Nurs. Heal. Serv.*, vol. 3, no. 5, pp. 615–621, 2020, doi: 10.35654/ijnhs.v3i5.280.

[11] M. Henry and J. Chambron, "Physico-chemical, biological and therapeutic characteristics of electrolyzed reduced alkaline water (ERAW)," *Water (Switzerland)*, vol. 5, no. 4. MDPI AG, pp. 2094–2115, 2013. doi: 10.3390/w5042094.

[12] S. Shirahata, T. Hamasaki, and K. Teruya, "Advanced research on the health benefit of reduced water," *Trends Food Sci. Technol.*, vol. 23, no. 2, pp. 124–131, 2012, doi: 10.1016/j.tifs.2011.10.009.

[13] W.-J. Zhu *et al.*, "Amelioration of cardio-renal injury with aging in dahl salt-sensitive rats by H 2-enriched electrolyzed water," 2013. [Online]. Available: http://www.medicalgasresearch.com/content/3/1/26

[14] R. Coffey and T. Ganz, "Iron homeostasis: An anthropocentric perspective," *Journal of Biological Chemistry*, vol. 292, no. 31. American Society for Biochemistry and Molecular Biology Inc., pp. 12727–12734, Aug. 04, 2017. doi: 10.1074/jbc.R117.781823.

[15] S. M. E. Rahman, T. Ding, and D. H. Oh, "Inactivation effect of newly developed low concentration electrolyzed water and other sanitizers against microorganisms on spinach," *Food Control*, vol. 21, no. 10, pp. 1383–1387, Oct. 2010, doi: 10.1016/j.foodcont.2010.03.011.

[16] J. R. Aunan, W. C. Cho, and K. Søreide, "The biology of aging and cancer: A brief overview of shared and divergent molecular hallmarks," *Aging and Disease*, vol. 8, no. 5. International Society on Aging and Disease, pp. 628–642, Oct. 01, 2017. doi: 10.14336/AD.2017.0103.

[17] F. S. L. G. Delos Reyes *et al.*, "The search for the elixir of life: On the therapeutic potential of alkaline reduced water in metabolic syndromes," *Processes*, vol. 9, no. 11. MDPI, Nov. 01, 2021. doi: 10.3390/pr9111876.

[18] N. Wang, H. Y. Tan, S. Li, Y. Xu, W. Guo, and Y. Feng, "Supplementation of micronutrient selenium in metabolic diseases: Its role as an antioxidant," *Oxidative Medicine and Cellular Longevity*, vol. 2017. Hindawi Limited, 2017. doi: 10.1155/2017/7478523.

[19] Y. Saitoh, Y. Harata, F. Mizuhashi, M. Nakajima, and N. Miwa, "Biological safety of neutral-pH hydrogen-enriched electrolyzed water upon mutagenicity, genotoxicity and subchronic oral toxicity," *Toxicol. Ind. Health*, vol. 26, no. 4, pp. 203–216, 2010, doi: 10.1177/0748233710362989.

[20] T. Hamasaki *et al.*, "Electrochemically reduced water exerts superior reactive oxygen species scavenging activity in HT1080 cells than the equivalent level of hydrogen-dissolved water," *PLoS One*, vol. 12, no. 2, Feb. 2017, doi: 10.1371/journal.pone.0171192.

[21] I. Uluisik, H. C. Karakaya, and A. Koc, "The importance of boron in biological systems," *Journal of Trace Elements in Medicine and Biology*, vol. 45. Elsevier GmbH, pp. 156–162, Jan. 01, 2018. doi: 10.1016/j.jtemb.2017.10.008.

[22] S. E. K. Wulandari ; A *et al.*, "The Effect of Combination Alkaline Water and Iron Tablets on Improving Hemoglobin Level among Adolescent," PT. Mizan Pustala, 2021.

[23] Y. Sun, J. Zheng, J. Yi, and S. Cai, "Investigation on the Effects and Mechanisms of Alkaline Natural Mineral Water and Distilled Water on Ethanol-Induced Gastric Ulcers In Vivo and In Vitro," *Processes*, vol. 10, no. 3, Mar. 2022, doi: 10.3390/pr10030498.

[24] M. Logozzi, D. Mizzoni, R. Di Raimo, D. Macchia, M. Spada, and S. Fais, "Oral administration of fermented papaya (FPP®) controls the growth of a murine melanoma through the in vivo induction of a natural antioxidant response," *Cancers (Basel).*, vol. 11, no. 1, Jan. 2019, doi: 10.3390/cancers11010118.

[25] S. H. T. T. K. Shirahata, "Advanced research on the health benefit of reduced water," *Trends Foods Sciens Technology,* vol. 23, no. 2, pp. 124-131, 2012.