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Consumer Attitudes Toward Public Water Supply Quality: Dissatisfaction and Alternative Water Sources

by LYNN L. CURRY

Southern Illinois University

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PREFACE

Public awareness of the quality of the environment and of the safety of public water supplies are related issues which have rarely received the attention that they deserve. The media infrequently treat the extent of scientific or public understanding of these issues directly, except as they relate to crisis situations. Selective coverage has resulted in an unbalanced public view of real versus perceived concerns as to the safety and quality of public water supplies.

This report seeks to document the basis for public dissatisfaction with public water supplies and specific reasons for the purchase of alternative drinking water sources. The study clearly demonstrates the need for improved consumer awareness of the objectives, competency, and limits of operations of water purveyors. The fact that we generally enjoy inexpensive, high quality water supplies for a variety of uses must be effectively brought to public attention. In this way, real concerns and future problems can be faced on a more reasoned basis by all concerned.

Michael J. Barcelona
Head, Aquatic Chemistry Section
State Water Survey Division
Illinois Department of Energy and
Natural Resources
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CONSUMER ATTITUDES TOWARD PUBLIC WATER SUPPLY QUALITY: DISSATISFACTION AND ALTERNATIVE WATER SOURCES

by Lynn L. Curry

ABSTRACT

A survey of consumers' attitudes was conducted to determine their perception of drinking water quality. Bottled water buyers and home water treatment unit users were polled to discern what led these consumers to reject or alter the available public drinking water. The study revealed that people who buy bottled water and home units are dissatisfied with the quality of the available drinking water supply and generally rate their water as poor.

The most frequent explanations for dissatisfaction with the quality of drinking water may be placed in three categories: aesthetic reasons, health reasons, and social reasons. Aesthetic concerns were primarily with taste and water hardness, then with floating particles (turbidity) and odor and color. The home unit buyers were shown to be largely concerned with aesthetic qualities such as taste and hardness, while the bottled water buyers more often expressed a concern with the potential health effects of the drinking water. Primary health concerns were found to be with the sodium content of the drinking water and the presence of chemicals. Social reasons for dissatisfaction with one's drinking water quality were not frequently cited. Questionnaire responses disclosed a lack of consumer awareness and confidence in the competency of public water supply personnel.

INTRODUCTION

Throughout history people have acknowledged and attempted to accommodate one of their most basic needs — an acceptable quality of drinking water. Pictures of water-clarifying apparatus found on Egyptian walls dating back to the 15th century B.C. offer evidence of prehistoric man's cognizance of his need for pure drinking water. The boiling of water, the use of wick siphons, filtration through porous vessels, and sand and gravel filtration have been utilized for thousands of years (Safe Drinking Water Committee, 1977).

Substantial evidence that a public water supply could be a source of disease was introduced by Dr. John Snow in 1854. He provided epidemiological studies of the incidence of cholera in London which showed that the disease was transmitted by the water supply from a polluted source to houses that were connected to this supply. Snow's

discovery was especially remarkable since the germ theory was not proposed until the 1860s (Safe Drinking Water Committee, 1977).

The realization of the cause/effect relationship of a poor quality of drinking water and the incidence of disease led to many improvements in treatment techniques during the 19th to early 20th centuries. In 1908 chlorination was introduced as a disinfection agent and water quality was further improved. Chlorine disinfection is considered by many to be the most significant sanitary and health achievement in modern times.

Up to the present, research and many technological advances have brought about major refinements in the water treatment and supply field. Continued water chemistry research has improved detection techniques for various constituents of natural waters. Therefore, many elements and compounds not previously detectable are now known to exist in drinking water. Many studies have been made concerning the risk and safety of chemical contaminants, the microbiology of drinking water, dissolved solids, suspended solids, organic and inorganic solutes, and the radioactivity of drinking water. From these studies, acceptable limits for many constituents have been established and are expected to be met by U.S. drinking water suppliers.

Rationale for Consumer Dissatisfaction with Drinking Water Quality and for the Purchase of Alternatives

There are several reasons why a person might be somewhat skeptical of water quality despite the standards that exist today for the supply of acceptable drinking water. Health concerns, individual preferences for certain aesthetic conditions, and consumer distrust of persons responsible for the quality of public drinking water are possible reasons why certain people deem it necessary to adjust or replace the available drinking water. The increase in sales of bottled water and home drinking water treatment devices may offer further evidence of growing concern. It is clear that people are seeking an alternative quality of drinking water to that which is made available by public services.

Health Concerns

The continuing study of water chemistry and drinking water treatment technology has raised numerous questions about the relationship of some human health problems to drinking water quality. Many uncertainties still exist in the scientific community as to what the safe acceptable limits are for certain drinking water constituents. Therefore, it is reasonable that some people question the health quality of their drinking water.

Many new potentially toxic chemical compounds and biological pollutants are introduced in the marketplace each year. Growing consumption of goods adds to the large number of compounds that are already finding their way into the water supply through industrial waste, domestic waste, and urban and rural runoff. Moreover, recent

research (Maugh, 1981; Westendorf and Middleton, 1979) has even shown that what was once thought to have been enhancement of drinking water may be potentially harmful to the consumer. Examples are chlorination and water softening treatments. In addition, the consumer is aware that mechanical malfunctions sometimes occur during the treatment of drinking water, resulting in the distribution of a poor quality of water.

Aesthetic Preferences

Aesthetic qualities such as taste, color, odor, hardness, and turbidity may also be factors causing people to buy bottled water or home treatment units. The bottled water and home treatment industries offer consumers several different types of bottled water and home filter units from which to choose to satisfy their particular needs.

Consumer Distrust

The public is aware that relatively little conclusive evidence exists pertaining to chemical constituents of drinking water and their potential human health effects. This awareness may support a growing suspicion and apprehension of what the "experts" and the public water supply personnel actually do know about drinking water quality and what they are telling the consumer. Therefore, another explanation for rejection of public drinking water may be consumer distrust of those persons who are responsible for the quality of the public drinking water. Consumers may be taking the situation into their own hands via alternative adjustments to the present supply.

Fashionability

A possible reason for the increase in bottled water and home treatment unit sales which must not be overlooked is that the purchase of these products has become fashionable. Perhaps these consumers are an elite group of people concerned primarily with the prestige associated with the purchase of such commodities.

Expansion of the Bottled Water and Home Filter Industries

Business in the bottled water industry is expanding greatly (table 1). In a recent report, "The U.S. Bottled Water Market: Feast or Famine in the 1980's," Business Trends Analysts, Inc. (BTA) noted that although bottled water may now be considered a luxury, it may soon become a necessity (Beverage Industry Annual Manual, 1979-1980). Given this frame of reference, and the fact that the potential demand for bottled water has barely been tapped, the future for this industry is bright indeed (Beverage Industry, 1982). Purified and processed water are projected to be the fastest growing sector of the bottled water market between 1980 and 1985.

No firm figures are available pertaining to the current market for residential drinking water units. However, in February 1980, the U.S. Environmental Protection Agency (EPA) staff estimated that 2 million

Table 1. Per Capita Consumption of Bottled Water in the U.S.

	Bottled water market, millions of $ (producers' prices)	Millions of gallons	Per capita consumption (gals/year)
1971		235	1.13
1975		245	1.15
1976	180	258	1.20
1977		280	1.29
1978		394	1.80
1979		453	2.04
1980	443	521	2.32
1985*	1,084	938	4.00

* Projected
Source: Beverage Industry Annual Manual, 1979-1980

units had been sold in the U.S. during 1979. EPA estimated that 80 percent of the units were small faucet models with an average price of $20, and 20 percent were in-line units averaging $200 each. On the basis of these estimates, EPA estimated the 1979 dollar sales volume of home water treatment units at $112 million. With various market observers noting an increase in public concern over drinking water quality, sales of point-of-use water treatment equipment are expected to increase substantially in the 1980s (Water Quality Association, 1981b).

The increase in sales of alternatives to public drinking water supplies is documented, yet a specific explanation for it is not readily available. What are the specific reasons for consumer dissatisfaction with public drinking water, which lead to further treatment of this water or the switch to a different source? This report attempts to provide some answers to these questions.

Plan of the Report

Following this introductory section, the report is divided into four sections. The "Background" section discusses previous studies of consumer perceptions and evaluations of drinking water quality, as well as current issues regarding various water constituents and treatment techniques. It also describes types of bottled water and home treatment units available on today's market.

The next section describes the design of the present study of consumer attitudes toward public water supply quality. The "Results and Discussion" section presents the results according to three groups of reasons for dissatisfaction with drinking water: health concerns, aesthetic reasons, and social reasons. It also describes the correlation between the results and levels of income, occupation, and education; and it gives the reasons stated by some respondents for not purchasing alternatives to their public water supply. The final section of the report offers some general conclusions.

The bibliography lists a large number of relevant publications, and the appendix presents the questionnaires mailed to study participants.

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BACKGROUND

Consumer Perception of Drinking Water Quality

There exists relatively little information concerning consumer perceptions of drinking water quality as compared to the vast amount of literature available on other aspects of drinking water quality, such as drinking water chemistry, treatment, distribution, and health effects. A document which deals directly with the issue of consumer perception is a paper by Baumann and Dworkin (1978). The authors discuss consumer attitudes toward drinking water, assess consumer preferences and behavior, and identify the range of alternative point-of-use treatment technologies available to the consumer who prefers a higher quality of drinking water than is presently available.

Several findings of a 1974 Gallup Poll concerning public attitudes and behavior regarding residential water quality can serve as benchmarks against which to measure future findings about attitudes and behavior. First, one survey revealed that there was "generally a high degree of satisfaction with the quality of water." Only one in four of those interviewed believed that water can affect health although the proportion was considerably higher among persons with a college background. A third finding was that 27 percent of those interviewed (amounting to 33 million people) who were not presently using treatment equipment to modify their drinking water quality would have been interested in doing so if price were not a problem (Gallup Organization, 1974).

In a review of consumer perceptions of taste and odor in drinking water (Bruvold, 1977) it was concluded that as the amount of total dissolved solids (TDS) in drinking water increases, consumers evaluate the water quality more and more negatively; that consumers perceive drinking water containing more than 500 milligrams per liter of total dissolved solids to be unacceptable; that the chemical composition of

TDS is a factor in consumer acceptance of the quality of the water; and that consumers are willing to pay for a significant improvement in the quality of their drinking water.

Current Topics Relative to Drinking Water Quality

Recent studies provide evidence of the potential relationship between certain drinking water characteristics and human health problems. Controversy exists within the scientific community concerning studies which have shown correlations between the chlorination of drinking water and human cancer; water hardness and cardiovascular disease (CVD); a high sodium content and CVD, hypertension, and kidney ailments; and dissolved fluoride and such conditions as the mottling of teeth and osteoporosis (a disease that results in weakened bone structure). Studies also have shown continuing outbreaks of waterborne disease in the United States (Safe Drinking Water Committee, 1982).

Chlorination and Human Cancer Risks

Chlorination is a proven economic measure to effectively disinfect public water supply. It has the desirable property of maintaining its effect in distribution systems. A current controversial aspect of disinfection is the possible link between chlorination and human cancer.

When chlorine is added to drinking water during the disinfection process, it can react with natural organic substances to form trihalomethanes (THM's). A major THM compound is chloroform, which is a known animal carcinogen. Limited epidemiological studies suggest tenuous correlations between chlorinated water and the potential risk of human rectal, colon, or bladder cancer.

Water Hardness and Cardiovascular Disease

Another controversial subject in the drinking water quality field concerns the relationship of water hardness to long-term health effects, especially cardiovascular disease (CVD). There exists a growing concern among public health authorities over epidemiological studies in several countries that indicate higher death rates from CVD in areas using soft drinking water compared to areas with hard water. In light of the available research, three primary hypotheses can be proposed as possible explanations for the relationship between water hardness and CVD (Westendorf and Middleton, 1979):

1) Hard water may contain certain bulk constituents such as calcium and magnesium which provide a protective effect against CVD. This effect could be caused by lowered intestinal absorption of toxic trace metals.

2) Trace elements normally associated with hard water could provide a protective effect. Certain metals, such as zinc and chromium, are essential for proper nutrition. Their absence could contribute to a dietary deficiency and could thus affect CVD rates

indirectly through a more weakened, susceptible population.

3) Trace constituents present in soft water could have a harmful effect on health and CVD rates. Certain soft water constituents like sodium, cadmium, and lead are toxic with known acute and chronic physiological effects.

Sodium in Drinking Water

Sodium in drinking water is believed to be a leading cause of several detrimental health conditions, including CVD, hypertension, and kidney ailments. There is contention about whether the correlation between high sodium content and these various ailments is valid, yet most doctors recommend that patients with such afflictions restrict their salt intake.

The Fluoridation Controversy

Fluoridation of drinking water is another treatment process which elicits dispute within the scientific community and the public alike. Fluoride addition is advocated by many since it has been shown to reduce tooth decay in a community by 60 percent (Spock, 1980). Yet, despite this benefit, many consumers object to fluoridation of public drinking water supplies, and anti-fluoridationists are challenging fluoridation in lawsuits in several states, including Illinois (Noah, 1981). Fluoridation opponents believe that mandatory fluoridation has been promoted without consumers being given a free choice in the matter.

Waterborne Disease

Despite significant advances in water treatment and disinfection practices, waterborne diseases continue to cause problems. From 1971 to 1978, 43 states and Puerto Rico reported 224 outbreaks of waterborne disease affecting more than 45,000 individuals (Safe Drinking Water Committee, 1982).

Most illnesses resulted from outbreaks in community systems rather than in private or individual systems. The major cause of outbreaks in community systems was contamination as a result of cross connections and back-siphonage. Treatment deficiencies, such as inadequate filtration and interruption of disinfection, were also responsible for a large number of outbreaks (Craun, 1981).

Need for Further Research

From the discussion above, it is evident that considerable controversy exists concerning several drinking water production practices and chemical constituents, and their potential effects on human health. In addition to the health questions, there are problems relating to' chemical analysis techniques and the limited number of comprehensive water supply studies that have been reported.

Much further research is essential in order to determine the relationship between drinking water and human health, as well as consumer perceptions of drinking water quality. Research is also needed to support improvement of water treatment practices and distribution system maintenance techniques. Definite benefits would accrue from sociological studies of consumer attitudes about public water supply. Such studies could identify areas of actual concern and lead to improvements in specific situations.

Options are available to those consumers who perceive public drinking water to be inadequate or possibly harmful. These individuals can switch their supply entirely by using bottled drinking water, or they can alter the quality of the public water by investing in a home drinking water treatment device.

Types of Bottled Water and Home Treatment Units

Four basic types of bottled water are available on the market today (What's What in Bottled Water?, 1979). In processed or specially prepared drinking water, all of the dissolved minerals are removed, and some are then added back to achieve a particular flavor. Natural water or spring water is bottled intact from a naturally flowing spring or well with all of the minerals left in. Mineral water, most of which is imported, contains a large amount of minerals. Sparkling water is effervescent spring water that has a subtle alkaline flavor.

Home treatment is the other principal alternative to drinking directly from public water supplies. No guarantees of success are provided with home units, and the extent of water treatment varies widely. There is a wide choice of technologies that can be used to modify the quality of present supplies of water at the household level. These include filtration, adsorption, deionization, distillation, disinfection, and reverse osmosis.

Many popular home filtration units employ particle filters combined with replacement cartridges of activated carbon to adsorb impurities. Some filters have silver impregnation intended to act as a bacterio-static agent to slow down the growth of germs. There are several types of carbon filters: pour-throughs; faucet filters which slip over the mouth of the tap; stationary types which are connected to the cold water pipe under the sink so that all the water flowing through is filtered; and line bypass types which are also connected under the sink but have a separate faucet so that unfiltered water can be obtained (Keough, 1980).

DESIGN OF THE STUDY

To discern why people seek alternatives to their existing drinking water supply, a mail questionnaire (Appendix) was distributed to a sample of 300 households. The questionnaire was designed to measure consumer perceptions of drinking water supplies, consumer dissatisfaction with available supplies, and, ultimately, the consumer

rationale for purchasing either bottled water or a home treatment unit. One hundred questionnaires went to each of three groups: 1) a group of bottled water buyers obtained from the delivery route records of a bottled water supplier; 2) a group of people who recently had purchased a home filter unit using reverse osmosis with activated carbon adsorption; and 3) a control group of 100 people from the same communities randomly chosen from the telephone book.

The communities involved in this study are located about 20 miles west of Chicago, Illinois, within a 15-square-mile area. Table 2 lists the communities, their populations, the sources of their water supplies, and the types of treatment used in their water treatment plants.

The response rates for the three groups were: 33 percent for the bottled water group, 51 percent for the home filter group, and 43 percent for the control group.

Table 2. Characteristics of Communities in Study Area: Population, Source of Water Supply, and Type of Treatment

	Population	Water supply source	Type of treatment
Countryside	Under 10,000	Lake Michigan	Chlorination
Hinsdale	19,000	10 shallow wells	Lime-soda ash softening; chlorination
LaGrange	17,000	1 deep well	Zeolite softening
		3 shallow wells	Chlorination Fluoridation
Western Springs	14,000	Deep well	Lime-soda ash Chlorination
Buffalo Grove	22,400	5 deep wells	Chlorination
Elk Grove Village	Under 29,000	Deep well	Chlorination
Lincolnshire	4,100	2 deep wells	Chlorination
Northbrook	31,000	Lake Michigan	Chlorination
Prospect Heights	12,500	Private wells	Direct use
		Shallow wells	Lime-soda ash softening
Wheeling	24,000	4 deep wells	Chlorination
		3 shallow wells	
Deerfield	18,000	Lake Michigan	Chlorination Fluoridation
Lake Villa	15,000	3 shallow wells	Chlorination
Arlington Heights	72,000	12 deep wells	Chlorination

Note: The depth of "shallow" wells ranges between 150 feet and 400 feet. The depth of "deep" wells ranges from 1300 feet to 1500 feet.

RESULTS AND DISCUSSION

The primary objective of this study is to identify the factors affecting consumer choice of drinking water. Dissatisfaction with the quality of public water supply was the dominant consumer sentiment. At least two-thirds of the total study group expressed some dissatisfaction and used either bottled water or home treatment units. The following discussion offers explanations for this professed consumer dissatisfaction with drinking water quality and indicates the consumer rationale for buying bottled water and home filters.

Consumer Dissatisfaction

The foremost reason for the purchase of bottled water and home treatment units was determined to be simply that the buyers were dissatisfied with either the quality of the drinking water supplied to them by the public water system or the quality of untreated private well water. Analysis of the data provided by this survey reveals that those in the control group (or people who do not use bottled water or home units) stated most often that they were indeed satisfied with the quality of their drinking water. There was a statistically significant difference between the control group and the other groups with respect to the appraisal of the public water supply. Fifty-eight percent of the control group responded positively about their drinking water quality as compared to the bottled water group, of which 75.8 percent stated that they were not satisfied. Similarly, 78.4 percent of the home filter group denoted dissatisfaction with the drinking water quality of the available supply (table 3). When asked to rate the quality of the public drinking water on a scale from very poor to excellent, the control group responded most favorably, generally declaring that their water quality was good. Only 14 percent rated their water quality as below fair. The bottled water and home filter groups demonstrated a marked contrast. Sixty percent and 75 percent, respectively, rated their drinking water as below fair, stating most frequently that the quality of their water is very poor.

Table 3. Consumer Satisfaction with the Quality of Available Drinking Water*

	Yes		No		No answer	
	Number	%	Number	%	Number	%
Bottled water group	7	21.2	25	75.8	1	3.0
Home treatment group	7	13.7	40	78.4	4	7.8
Control group	25	58.1	15	34.9	3	7.0

*Response to question on mailed questionnaires: "Are you satisfied with the quality of your public drinking water?"

The specific causes for dissatisfaction with one's drinking water can be placed into three separate categories — dissatisfaction generated by a concern with the relation between drinking water and health, dissatisfaction with certain aesthetic qualities of the drinking water, and dissatisfaction induced by a lack of confidence in the competence and trustworthiness of those people responsible for drinking water quality.

Health Concerns

The relationship between health and the quality of the drinking water is a very prevalent concern of nearly half of the individuals involved in this study. For some of the respondents, this concern resulted in the purchase of either bottled water or a home filter unit. When queried about the reasons for their decision to buy bottled water or a home filter, 57.6 percent of the bottled water group and 39 percent of the home filter group responded that it was for health reasons. Members of the control group did not choose to alter the quality of their drinking water; therefore there is no comparable response. Specific aspects of the health concerns shown by individuals in this study are discussed below.

Sodium and Other Minerals. The minerals in potable water include many ionic chemical species, among them sodium, potassium, calcium, magnesium, chloride, sulfate, and nitrate. Common salt (sodium chloride) is only one mineral constituent of drinking waters, but when water has a high dissolved mineral content, it may have a taste that is identified by consumers as "salty." About one-third of both the bottled water and the home treatment groups stated that the high salt content of the water led them to purchase alternative water sources. (The control group was not asked a comparable question and therefore did not mention the salt or mineral content of the water.)

The possibility that high mineral content and corresponding increased sodium intake causes cardiovascular disease, hypertension, and kidney ailments may be a source for concern.

Table 4 summarizes sodium levels for the communities used in this study, along with levels of other relevant water quality parameters. In almost all the communities, the sodium levels are far below the levels that would be considered a health hazard (above 450 mg/L as sodium chloride; Walker, 1978); yet many consumers expressed a concern (perhaps needlessly) about their water quality with regard to sodium content.

Chemicals in Drinking Water. Another apparent health concern noted by some of the respondents related to the presence of chemicals, although the particular types of chemicals were seldom specified. Such chemical constituents as fluoride and chlorine are among those regarded as objectionable. Nine percent of the bottled water group, 2.0 percent of the home filter group, and 4.7 percent of the control group considered fluoride addition to be a problem and 12.1 percent, 9.8 percent, and 18.6 percent, respectively, considered chlorine treatment to be detrimental to health. There is not a statistically significant difference between the responses from the control group and those from individuals using alternative drinking water sources.

Table 4. Water Quality Parameters for Communities in Study (Concentrations in milligrams per liter)

	Sodium	Total diss. solids	Fluoride	Chloride	Hardness(as mg/L $CaCO_3$)
Max. allowable concentration:	No limit	500 mg/L (guideline)	1.8 mg/L	No limit	No limit
Countryside	7.0	190	1.05	13.0	152
Hinsdale	196	723	1.0	113	162
LaGrange	500	1240	0.91	327	123
Western Springs	83.0	380	1.13	45.0	109
Buffalo Grove	35.0	400	1.11	14.0	314
Elk Grove Village	42.0	400	0.96	17.0	278
Lincolnshire	37.0	460	1.23	16.0	311
Northbrook	5.0	160	1.13	10.0	139
Prospect Heights	87.0	550	1.31	70.0	275
Wheeling	43.0	470	1.16	19.0	294
Deerfield	6.0	190	0.68	12.0	139
Lake Villa	39.0	350	1.02	2.7	266
Arlington Heights	37.5	380	1.08	13.0	276

Radiation in Drinking Water. Surface and ground waters may acquire a small amount of radioactivity from rocks and minerals with which they have been in contact. This is known as "background level" radiation. Industrial wastes may contain small quantities of radioactive materials since radioactive chemicals are extensively used in the X-ray examination of welds and the structural soundness of materials. Also, small quantities of radioactive materials are used in medicine and in the watch industry. Nuclear power plant operations involve the use of large quantities of uranium and other radioisotopes to generate heat. Radioactive materials can reach water sources from natural sources as well as by releases from landfills.

Radiation in drinking water is a health concern mentioned exclusively by the home filter group. Eight percent of these people mentioned that it was a cause for dissatisfaction with their drinking water quality.

Aesthetic Reasons

Another factor that plays a role in a person's perception of drinking water quality, which can influence the consumer decision to buy bottled water or a home filter, is the aesthetic quality of the water. Aesthetic parameters of drinking water include the water's specific taste, odor, hardness, turbidity (cloudiness caused by presence of particulate matter), and color.

Taste. Preference for a special taste of water is highly subjective. Each individual has a different perception of what a "good" tasting water is. Generally, people prefer a drinking water that is

relatively "taste-free" (Walker, 1978), although research has also indicated (Bruvold, 1975) that clearly detectable mineral taste in water may not be unacceptable for daily drinking. Chlorine, algae, iron, manganese, sediment, and organic matter are several causes of taste problems.

Bad taste was the aesthetic quality most frequently cited for causing dissatisfaction with the public drinking water supply. Statistical analysis reveals a significant correlation between consumer perceptions of drinking water taste and the decision to purchase bottled water or a home filter. The bottled water and home filter buyers designated at least six times more often than did the control group that the taste of the public water was displeasing. More than 63.6 percent of the bottled water buyers and 56.9 percent of the home filter buyers acknowledged that this bad taste was a source of dissatisfaction. Only 9.3 percent of the people in the control group stated that bad taste was a problem with their community water supply.

Odor. Bad odors are related to bad taste and usually originate from biological sources such as algae, decaying organic matter, and various side reactions initiated by bacteria. About 21 percent of the bottled water group, 19.6 percent of the home filter group, and 11.6 percent of the control group designated that their public water has an unpleasant odor. Malodorous drinking water is a consumer concern and thereby a potential cause for dissatisfaction with the available drinking water supply. There was not a significant difference between the three groups regarding this water parameter. However, while 15.2 percent of the bottled water group indicated that malodorous drinking water caused them to purchase bottled water, only 2 percent of the home treatment group (1 household) indicated this as a reason for the purchase of an alternative.

Hardness. When asked why they were dissatisfied with the quality of their available drinking water supply, nearly 38 percent of the total study group stated that the water was too hard. A breakdown into consumer groups reveals that 33.3 percent of the bottled water group, 52.9 percent of the home treatment group, and 23.3 percent of those in the control group responded in this way. To further elaborate this point, when asked why they bought the alternatives, 12.1 percent of the bottled water group and 43.1 percent of the home treatment group responded that water hardness was a factor.

Hardness levels of each community's drinking water are shown in table 4. A majority of the home treatment group respondents actually were served by the public water supplies with a high level of hardness (>150 mg/L). It is interesting to note that responses from the control group, who also received mainly high hardness water, less frequently cited hardness as a disagreeable characteristic of their water. On the other hand, the bottled water group respondents receiving public water supplies of low to medium hardness still judged their water to be too hard.

Clearly, hardness is a very subjective quality of public water supplies as perceived by the public.

Turbidity. Eighteen percent of the total study sample attributed their dissatisfaction with the quality of the public drinking water to the presence of floating particles, or turbidity. This condition can be caused by the presence of suspended matter such as clay, silt, organic and inorganic matter, plankton and other microscopic organisms, or finely divided air bubbles.

Turbidity is objectionable not only for the sake of appearance. The presence of particulate matter also interferes with the chlorination process. Furthermore, floating matter in the water can provide safe habitats for various pathogenic organisms which might also be present in the water.

Analysis of the data discloses a statistically significant correlation between the consumer group variable and discontent with the turbidity of public drinking water. More than 30 percent of the bottled water buyers and 21.6 percent of the home treatment group mentioned this water quality condition as a cause of dissatisfaction with their public water supply, while only 7 percent of the control group responded similarly.

Color. Pure water is colorless. The presence of dissolved foreign substances such as decomposing vegetation, organic compounds, and metals can cause a water to become blue, green, yellow, or brown according to the amount and nature of the materials present. It is believed that the organic compounds that cause color are not harmful to health, but they will reduce the effectiveness of chlorine as a disinfectant.

The color of their drinking water was considered to be objectionable by 13.4 percent of the total sample group. A displeasing color of drinking water caused 18.2 percent of the bottled water group and 11.8 percent of the home treatment group to be dissatisfied with the public supply and motivated 9.1 percent of the former group and 9.8 percent of the latter group to invest in the respective commodities. Although the bottled water group showed a somewhat higher frequency of dissatisfaction with the color of the available drinking water, there is no statistically significant difference between the three groups concerning the color of drinking water and consumer dissatisfaction or the purchase of bottled water or home filters.

Tables 5 and 6 present summaries of reasons for consumer dissatisfaction with public drinking water and for the purchase of alternatives.

Social Reasons

Consumer Distrust of Persons Responsible for Drinking Water Quality. According to the results of this survey, many individuals exhibit a lack of knowledge about those responsible for the treatment and distribution of public drinking water. Only 8 percent of the total study group was unaware of their water source, and most of the respondents who were aware of the source of their water were able to correctly identify it. However, there was a considerable gap in both

Table 5. Reasons Stated for Dissatisfaction with Public Drinking Water: Ranking of Six Most Frequent Responses

Reasons	Bottled water group			Home treatment group			Control group		
	Number	Rank	%	Number	Rank	%	Number	Rank	%
Bad taste	21	1	63.6	29	1	56.9	4	4	9.3
Too hard	11	2	33.3	27	2	52.9	10	1	23.3
Floating particles	10	3	30.3	11	3	21.6	3	5	7.0
Bad odor	7	4	21.2	10	4	19.6	5	3	11.6
Displeasing color	6	5	18.2	6	5	11.8	5	3	11.6
Salt content	6	5	18.2	4		7.8	0	0	0
Chlorine treatment	4		12.1	5	6	9.8	8	2	18.6
Addition of fluoride	3		9.1	1		2.0	2		4.7
Presence of chemical wastes	0		0	2		3.9	1		2.3
Lack of fluoride	0		0	2		3.9	0		0
Too soft	1		3.0	1		2.0	0		0
Radiation	0		0	4		7.8	0		0

Source: Mail questionnaire

Table 6. Reasons Stated for Buying Bottled Water and Home Treatment Units

	Bottled water group			Home treatment group		
	Number	Rank	%	Number	Rank	%
Health reasons*	19	1	57.6	20	3	39.2
Preferred a different taste	18	2	54.5	28	1	54.9
Too hard	4	5	12.1	22	2	43.1
Preferred a different mineral content	6	3	18.2	13	4	25.5
Odor was displeasing	5	4	15.2	1		2.0
Color was displeasing	3		9.1	5	5	9.8
Too soft	2		6.1	4		7.8
It is popular	0		0	0		0
Preferred a different amount of bubbles	0		0	0		0
*Specified health reasons						
Salt	10		30.3	19		37.3
Chemicals	6		18.2			

Source: Mail questionnaire

consumer awareness of and confidence in those responsible for the operation of their public water supply.

Close to 58 percent of the bottled water group, 47.1 percent of the home filter group, and 44.2 percent of the control group indicated that they did not know if water suppliers are competent at their jobs (table 7). When asked if they were sure that suppliers always tell the truth about the quality of this public drinking water, a large majority in each study group responded "No" or "Don't know" (table 8).

There are several possible reasons why consumers might have a lack of trust in water suppliers. Most consumers are aware that community water treatment plants can indeed have problems with the treatment and distribution of drinking water. Occasional malfunctions are unavoidable and can occur because of equipment failure, human error, or an uncontrollable circumstance such as an exceedingly heavy rainfall.

Consumers may be skeptical of what they are told about their drinking water quality since there is such a diversity of opinion within the scientific community as to the health effects of such constituents as sodium, water hardness, and chlorine. One cannot be too surprised that this analysis shows that consumers have doubts about their drinking water quality as well as the competency of those who supply it. Many feel that there is not enough solid evidence concerning adverse health effects of different drinking water constituents on which to base limits for the different constituents. Misinformation and a lack of public understanding of both water resource problems and management strategies probably contribute to consumer dissatisfaction.

Table 7. "Do You Feel That Those People Who Are Responsible for Your Drinking Water Are Competent at Their Jobs?"

	Bottled water group		Home treatment group		Control group	
	Number	%	Number	%	Number	%
Yes	8	24.2	17	33.3	21	48.8
No	5	15.2	7	13.7	2	4.7
Don't know	19	57.6	24	47.1	19	44.2
No response	1	3.0	3	5.9	1	2.3

Source: Mail questionnaire

Table 8. "Are You Sure That the People Who Supply Your Public Drinking Water Are Always Telling You the Truth About Its Quality?"

	Bottled water group		Home treatment group		Control group	
	Number	%	Number	%	Number	%
Yes	3	9.1	4	7.8	6	19.0
No	13	39.4	16	31.4	17	39.5
Don't know	15	45.5	26	51.0	18	41.9
No response	1	3.0	5	9.8	2	4.7

Source: Mail questionnaire

Fashionability. The possibility that people purchase bottled water and home treatment units because doing so is the current consumer trend must not be overlooked as a plausible explanation for the prosperity of the bottled water and home treatment industries. Yet not one of the survey respondents submitted that the growing popularity of these products influenced their decision to reject or alter their drinking water source.

Income, Occupation, and Education

One might expect people in higher income brackets to have more of an expendable income for what may be considered nonessential commodities, namely bottled water and home treatment units. This study found that bottled water buyers and home filter users held somewhat more prestigious and higher paying jobs than the majority of individuals in the control group (table 9). The educational levels of the three groups support the assumption that people in higher educational and occupational brackets tend to be the primary consumers of bottled water and home units.

Table 9. Occupational, Educational, and Income Levels of Study Respondents

	Bottled water buyers		Home treatment unit buyers		Control group	
	Number	%	Number	%	Number	%
Occupational level*						
I	12	36.4	10	19.6	1	2.3
II	9	27.3	11	21.6	8	18.6
III	4	12.1	16	31.4	10	23.3
IV	3	9.1	4	7.8	12	27.9
V	1	3.0	2	3.9	5	11.6
VI	1	3.0	2	3.9	3	7.0
VII	0	0	0	0	1	2.3
VIII	0	0	4	7.8	0	0
No response	3	9.1	2	3.9	3	7.0
Educational level						
High school graduate	4	12.1	9	17.6	23	53.5
College degree	20	60.6	25	49.0	14	32.6
Masters	4	12.1	6	11.8	3	7.0
Ph.D.	2	6.1	5	9.8	2	4.7
Some grad school	2	6.1	2	3.9	0	0
Some college	1	3.0	2	3.9	0	0
No response	0	0	2	3.9	1	2.3
Income level						
9,999 and below	0	0	2	3.9	0	0
10,000-14,999	2	6.1	1	2.0	3	7.0
15,000-24,999	1	3.0	2	3.9	10	23.3
25,000-34,999	4	12.1	5	9.8	6	14.0
35,000-49,000	6	18.2	14	27.5	15	34.9
50,000 and above	9	27.3	18	35.3	4	9.3
No response	11	33.3	9	17.6	5	11.0

* I = higher executives, proprietors of large concerns, major professionals; II = business managers, proprietors of medium sized businesses, lesser professionals; III = administrative personnel, small independent businesses, and minor professionals; IV = clerical/sales workers, technicians, owners of little businesses; V = skilled manual employees; VI = machine operators, semi-skilled employees; VII = unskilled employees; VIII = retired

On the basis of this analysis, there is a statistically significant correlation between consumer group and educational and occupational status — members of the bottled water and home treatment unit groups generally have a higher socioeconomic status than members of the control group.

Control Group Rationale for Not Purchasing Bottled Water and/or a Home Unit

When members of the control group were asked to explain why they did not invest in any drinking water improvement commodities, the most frequent reply (55.8 percent) was that the participant was satisfied with the public drinking water. The next most frequent reply was that bottled water and home treatment units were too expensive.

To gain insight into how the control group members might serve as a potential market for these commodities, the respondents were asked if they planned to purchase either bottled water or a home unit in the near future (i.e., within the year). Most said they did not.

CONCLUSIONS

This study provides some insights into the factors related to the decision to buy bottled water or a home treatment unit as alternatives to public drinking water.

Reasons given by bottled water buyers and home treatment unit users for dissatisfaction with the quality of the public drinking water showed a marked similarity. The four most objectionable features of public drinking water mentioned by both groups were (in decreasing order of importance): objectionable taste, high level of hardness, floating particles, and bad odor.

However, the most frequently indicated reasons for buying either bottled water or a home treatment unit were different for each group. Close to 55 percent of the home filter users stated that they wanted a better-tasting drinking water. The next most frequently indicated response by the home filter group was that the public drinking water was too hard. Thirty-nine percent of these respondents expressed a concern for possible adverse health effects.

In comparison, 54.5 percent of the bottled water group stated that they altered their drinking water because of taste preferences, but health concerns were more important than taste for this group. Almost 58 percent said they switched to an alternative drinking water supply because of health reasons.

The results of this survey indicate that bottled water buyers may be more concerned than home treatment unit buyers with the health quality of their drinking water.

It is important for drinking water suppliers to appreciate consumers' preferences for improved taste, odor, and color as well as their concerns about health effects. It may be as important for decision makers to consider these preferences as it is to consider the water's actual health hazards and aesthetic quality.

If people perceive their water to be inadequate or unsatisfactory for drinking purposes, they may become anxious or dissatisfied with it on the basis of this perception, whether or not the perception is well-founded. Misinformation or lack of honest disclosure of public water supply problems may aggravate this situation. Further, it may contribute to consumer distrust of the water purveyor, the product, and government officials responsible for utility oversights. The water industry, scientists, and public officials should realize the need to improve consumer awareness concerning the quality and safety of public drinking water.

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APPENDIX

COVER LETTER AND QUESTIONNAIRES MAILED TO BOTTLED WATER BUYERS, HOME FILTER BUYERS, AND CONTROL GROUP

November 4, 1981

Hello,

I am a graduate student at Southern Illinois University in Carbondale and am currently collecting information for my master's thesis. The concern of my study is to assess people's attitudes toward the quality of their drinking water.

If you would please take a few minutes to fill out the enclosed questionnaire, I would be most grateful. Your responses will be held in strict confidentiality. Upon completion of the form, simply fold it along the dotted line, staple or tape it, and mail it back (the postage is already paid).

If you wish to receive the results of this survey, please place your name and address on the return envelope in the upper left-hand corner.

Thank you for your assistance.

Sincerely,

Lynn L. Curry

Lynn L. Curry

Bottled Water Buyer Questionnaire

Please respond to the following questions to the best of your knowledge.

1. What is your current source of public drinking water? Check one.

   ___a private well ___a public well ___a man-made reservoir
   ___a river ___a natural lake ___do not know
   ___a combination of _____ and _____

2. Generally, how would you rate the overall drinking water quality of this water supply on the scale below? Please circle the number.

   1 2 3 4 5 6 7 8 9

   very poor poor fair good excellent

3. Are you satisfied with the quality of your public drinking water? ____yes ____no

4. If not, why not? Please check those that apply:

   ___bad taste ___presence of floating particles ___displeasing color
   ___bad odor ___chlorine treatment ___too hard ___too soft
   ___addition of flouride ___lack of flouride
   ___presence of chemical waste products, please specify: _____
   ___other, please explain: _____

5. Do you drink bottled water? ___yes ___no

6. If yes, how often? ___1-2 glasses daily ___3-5 glasses daily
   ___other, please specify: _____

7. Please check those reasons that would explain why you decided to buy bottled water and use the space below to further explain*.

   ___preferred a different taste ___preferred a different mineral content
   ___color was displeasing ___odor was displeasing
   ___water was too hard ___water was too soft
   ___it is popular ___preferred a different amount of bubbles
   ___health reasons, please specify: _____

   *Please briefly explain: _____

   _____

8. Do you feel that those people who are responsible for your drinking water are competent at their jobs? ___yes ___no ___don't know

How competent? ___not at all ___moderately ___very competent

9. Are you sure that the people who supply your public drinking water are always telling you the truth about its quality?

___yes ___no ___don't know

10. Has the water treatment plant in your community had any problems with supplying a good quality of drinking water?

___yes ___no ___don't know

If yes, please explain: _____

11. Do you think that more research is needed to better understand the relation between drinking water quality and health?

___yes ___no ___don't know

Please check the appropriate response:

12. Year of birth: _____ 13. Sex: ___male ___female

14. Please state your occupation: _____
and occupation of your spouse (if applicable): _____

15. Length of time you have lived in your community: _____

16. Level of education:

___non-high school graduate
___high school graduate
___college degree
___master's degree
___Ph.D.

17. Household Income:

___$9,999 or less
___between $10,000 - $14,999
___between $15,000 - $24,999
___between $25,000 - $34,999
___between $35,000 - $29,999
___between $50,000 and more

THANK YOU VERY MUCH FOR YOUR ASSISTANCE

Home Filter Buyer Questionnaire

Please respond to the following questions to the best of your knowledge.

1. What is your current source of public drinking water? Check one.

___a private well ___a public well ___a man-made reservoir
___a river ___a natural lake ___do not know
___a combination of _____and _____

2. Generally, how would you rate the overall drinking water quality of this water supply on the scale below? Please circle the number.

1 2 3 4 5 6 7 8 9

very poor poor fair good excellent

3. Are you satisfied with the quality of your public drinking water? ___yes ___no

4. If not, why not? Please check those that apply:

___bad taste ___presence of floating particles ___displeasing color
___bad odor ___chlorine treatment ___too hard ___too soft
___addition of flouride ___lack of flouride
___presence of chemical waste products, please specify: _____
___other, please explain: _____

S. Do you have a drinking water treatment filter in your home? ___yes ___no

6. If yes, what type? _____

7. Please check those reasons that would explain why you decided to buy a home filter unit and use the space below to further explain*.

___preferred a different taste ___preferred a different mineral content
___color was displeasing ___odor was displeasing
___water was too hard ___water was too soft
___it is popular ___preferred a different amount of bubbles
___health reasons, please specify: _____

*Please briefly explain: _____

_____

8. Do you feel that those people who are responsible for your drinking water are competent at their jobs?

___yes ___no ___don't know

How competent? ___not at all ___moderately ___very competent

9. Are you sure that the people who supply your public drinking water are always telling you the truth about its quality?

___yes ___no ___don't know

10. Has the water treatment plant in your community had any problems with supplying a good quality of drinking water?

___yes ___no ___don't know

If yes, please explain: _____

11. Do you think that more research is needed to better understand the relation between drinking water quality and health?

___yes ___no ___don't know

Please check the appropriate response:

12. Year of birth: _____ 13. Sex: ___male ___female

14. Please state your occupation: _____
and occupation of your spouse (if applicable): _____

15. Length of time you have lived in your community: _____

16. Level of education:

___non-high school graduate
___high school graduate
___college degree
___master's degree
___Ph.D.

17. Household Income:

___$9,999 or less
___between $10,000 - $14,999
___between $15,000 - $24,999
___between $25,000 - $34,999
___between $35,000 - $49,999
___between $50,000 and more

THANK YOU VERY MUCH FOR YOUR ASSISTANCE

Control Group Questionnaire

Please respond to the following questions to the best of your knowledge.

1. What is your current source of public drinking water? Check one.

__a private well __a public well __a man-made reservoir
__a river __a natural lake __do not know
__a combination of _____ and _____

2. Generally, how would you rate the overall drinking water quality of this water supply on the scale below? Please circle the number.

1 2 3 4 5 6 7 8 9

very poor poor fair good excellent

3. Are you satisfied with the quality of your public drinking water? __yes __no

4. If not, why not? Please check those that apply:

__bad taste __presence of floating particles __displeasing color
__bad odor __chlorine treatment __too hard __too soft
__addition of flouride __lack of flouride
__presence of chemical waste products, please specify: _____
__other, please explain: _____

5. If you do not buy either bottled water or own a home drinking water filter, please check the reason(s) why you do not:

__I am satisfied with the public drinking water.
__Bottled water is too expensive.
__Bottled water is not particularly any safer than the available supply.
__Home treatment filters are too expensive.
__Performance of the home filter unit is ineffective.
__I was not aware of the availability of home treatment filters or bottled water.
__Too inconvenient (please state how you feel they might be an inconvenience):

_____

_____

__Other reasons, please specify: _____

_____

__I use bottled water. __I use a home treatment filter unit.

6. Do you plan to purchase a home drinking water filter in the future, say within a year?

__yes __no __had not considered it

Bottled water? __yes __no __had not considered it

7. Do you feel that those people who are responsible for your drinking water are competent at their jobs?

__yes __no __don't know

How competent? __not at all __moderately __very competent

8. Are you sure that the people who supply your public drinking water are always telling you the truth about its quality?

__yes __no __don't know

9. Has the water treatment plant in your community had any problems with supplying a good quality of drinking water?

__yes __no __don't know

If yes, please explain: _____

10. Do you think that more research is needed to better understand the relation between drinking water quality and health?

__yes __no __don't know

Please check the appropriate response:

11. Year of birth: _____ 12. Sex: __male __female

13. Please state your occupation: _____

and occupation of your spouse (if applicable): _____

14. Length of time you have lived in your community: _____

15. Level of education:

__non-high school graduate
__high school graduate
__college degree
__master's degree
__Ph.D.

16. Household Income:

__$9,999 or less
__between $10,000 - $14,999
__between $15,000 - $24,999
__between $25,000 - $34,999
__between $35,000 - $49,999
__between $50,000 and more

THANK YOU VERY MUCH FOR YOUR ASSISTANCE