Can sparkling water makers minimize our ecological footprint?

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Abstract

Germans love their fizzy water: The predominant part of consumed water is carbonated.

Nevertheless, the favored use of tap water was confirmed within prior research conducted at our school.

Multiple companies developed a device that combines both demands - homemade carbonated tap water. So-called sparkling water makers are often advertised with a promise to the consumer of saving money and living a more sustainable lifestyle.

This goal is supposedly reached by decreasing the amount of sold plastic bottles and therefore a decline in plastic waste.

We are going to analyze whether the use of a sparkling water maker can reduce an individual's ecological footprint, looking at different indicators in an everyday-life setting compared to bottled water.

The research and work for this project is mainly done to raise awareness of our school members for the upsides a sparkling water maker could potentially have.

These advantages are beneficial for them as individuals as well as they contribute to preserving our most important ecosystem, planet earth.

Keywords

Sparkling water, ecological footprint, Germany, sparkling water maker

1 The purpose of research

Our school team from 2018 found out, that drinking tap water in Germany provides more benefits than drinking bottled water. Tap water is cheaper and has both economic and ecological advantages.

Thanks to their research the students of our school are more aware of their water consumption and prefer tap water.

Nevertheless, there are still a lot of people who buy bottled water, because unlike tap water it is carbonated. Almost half of the German population prefer carbonated water.

This leads us to the question if people would drink tap water also if it was carbonated. After a brief research, we ascertained that the use of so-called sparkling water makers, such as SodaStream®, are very common in German households.

Therefore, the purpose of our research is to figure out, if a sparkling water maker provides more advantages than bottled water. The research involves comparisons in sustainability and costs between bottled water and sparkling water that was carbonated with a sparkling water maker.

2 Method of research

To make sure that we can build on last time's research, which pertained to the students of our school, we agreed to do a survey to figure out how many students at our school drink tap water and how many prefer sparkling water. Then we evaluated the survey and compiled statistics, to simplify the following steps.

Next, we compared homemade sparkling water to bottled sparkling water in terms of costs, effects on the environment and effects on human health. For costs, we did research about the prices of bottled carbonated water per liter. We analyzed the best-known labels and compared those to the costs of tap water.

Then we investigated the asset costs of a sparkling water maker including the costs for the carbon dioxide cylinder and tap water. We extrapolated the costs per year. We compared these costs with the costs of the purchase of bottled carbonated water per year to conclude which method of drinking sparkling water is cheaper.

Subsequently, research on the environmental effects of bottled sparkling water was started. As one measure for the environmental effect we choose the carbon footprint. According to Merriam-Webster, the carbon footprint is defined as "the amount of greenhouse gases and specifically carbon dioxide emitted by something (such as a person's activities or a product's manufacture and transport) during a given period". We calculated the average carbon dioxide emissions of an average household at our school to get an idea of our school's household carbon footprint. For this, we analyzed the emissions of both diesel and petrol cars to compute the average carbon dioxide emissions per kilometer. Then we figured out the average distances, which were driven by the households at our school to go buy water. Here, we split the distances into three main groups; routes that last less than five minutes, routes that last between five and ten minutes and routes that last more than 10 minutes. After this, we estimated the carbon dioxide emissions of each route and both kinds of fuel per year.
In addition, the negative effects of the plastic bottles, which were found out by research, are shown and compared to reusable bottles. Finally, the effects on human health are pointed out and a conclusion can be drawn.

3 Survey

3.1 Approach of survey

The aim of the conducted survey was to figure out the average consumption behavior of households of students at the Dillmann-Gymnasium. The survey was anonymous and voluntary. In the end, 323 households participated. To get valid results, we asked the students to complete the survey at home together with their parents as they might be able to give more precise answers concerning the water drinking behavior of the households. We asked both, open and closed questions and multiple answers were allowed.

Questions number 2, 3, 4, 5, 7, 9, 10 and 11 were closed questions with predefined answers. Question number 1, 6 and 8 were open questions so that we could get more precise answers from our respondents.

3.2 Results of survey

Question 1: With how many people do you live in a household?

The average number of adults per household, so people with a minimum age of 18, was two. Additionally, each household had about two children, defined as being below the age of 18.

That makes a total of an average 4 people per household.

Question 2: What type of water does your household favour?

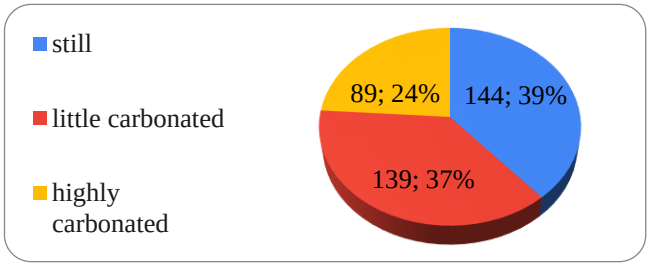

Figure 1: Answers Question 2

As Figure 1 shows, about 39% of the households prefer drinking still water and another 37% prefer their drinking water when it is carbonated. Only about 24% of the households prefer drinking highly carbonated water.

These results show that about 40% of the households do not actually require a sparkling water maker, since they do not prefer carbonated drinking water.

Question 3: Are you buying your drinking water?

Figure 2 shows, that there is an almost equal distribution in households buying their drinking water and households that are drinking tap water.

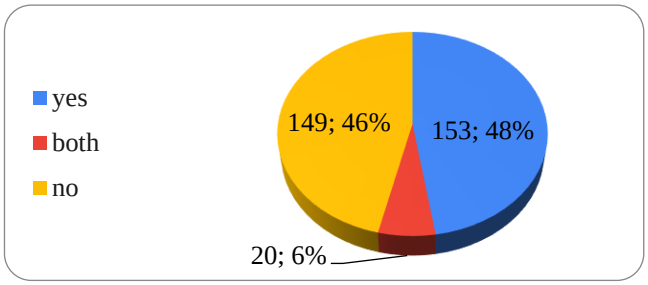

Figure 2: Answers Question 3

Question 4: If you buy your drinking water, in what type of bottles do you buy it?

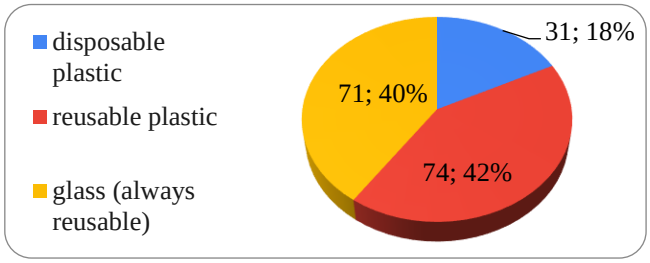

Figure 3: Answers Question 4

Among the participants, about 40% are buying their drinking water in glass bottles. The remaining 60% are buying plastic bottles. In Germany, we distinguish between two types of plastic bottles: disposable and reusable plastic bottles. The key difference between those two types is how they are dealt with after they have been used. The disposable bottles are recycled and then the recycled plastic can be used for something else. In contrast, the reusable bottles are, as the name already suggests, reused by refilling them.

Question 5: If you buy your drinking water, how do you go water shopping?

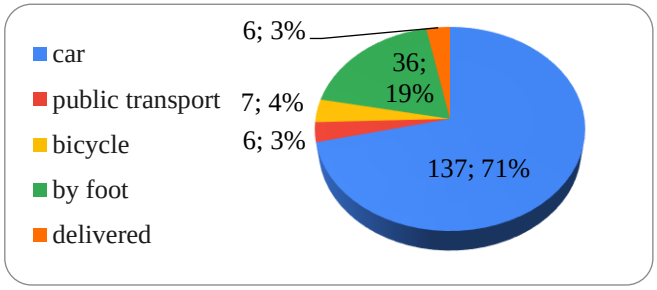

Figure 4: Answers Question 5

The most frequent answer to question 5 was using the car as their main means for transportation, in total 71% of the participating households. 19% of the households name going walking as their means of transportation in order to get their drinking water.

Question 6: If you buy your drinking water, where do you purchase it?

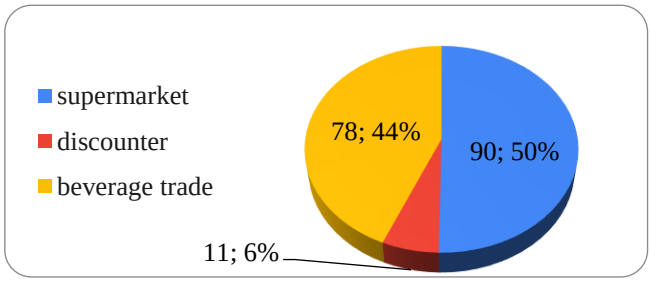

Figure 5: Answers Question 6

About half of the questioned households, that go water shopping, named the supermarket as their preferred place to buy water. Another 44% stated that they would go to specialized beverage supermarkets and the remaining 6% buy at discounter supermarkets.

Question 7: If you are buying your drinking water, how often do you go water shopping?

This question was designed as an open question in order to receive exact results. The outcome was an average of 2.8 times per month.

Since 137 households are going by car, about 383.6 trips to get their drinking water would be made only at our school per month. This number seems pretty high, considering that in Germany for each household it is possible to drink tap water.

Question 8: If you buy your drinking water, how many bottles do you buy for one week?

The mean number of bottles bought for one week is 8. That makes a total of 416 bottles per household per year. The 174 households at our school are leaving behind about 72.4 water bottles per year. Such a high number could easily be reduced if the households would start drinking tap water.

Question 9: If you buy your drinking water, what bottle capacity/capacities do you buy?

The exact average of bottle capacities is about 0.63 liters. Such a capacity is not available at stores, but stores offer 0.5-liter bottles.

Question 10: If you buy your drinking water and go by car, how long does it take you to get there?

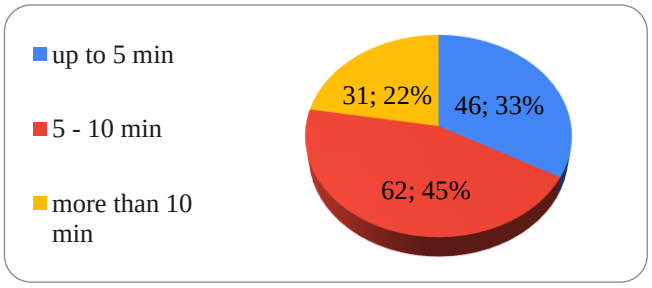

Figure 6: Answers Question 10

In total 45% are driving 5 to 10 minutes to their water store of choice. Another 33% are only driving up to 5 minutes. The remaining 22% are driving more than 10 minutes to get to their water store.

We elaborated on shopping behaviors based on the driving time. The longer, thus the further away your water store of choice is, the more likely you are to go less often and you are more likely to buy high capacity bottles. Surprisingly, households, that are driving longer are more likely to go to a specialized beverage supermarket for their water supply.

Question 11: Does your household own a sparkling water maker (e.g. SodaStream)?

In total, 102 of the questioned households own a sparkling water maker. This is only about a third of the 323 participating households. Interestingly about 18% of the households that own such a device are as well buying water. This seems like an unnecessary expenditure regarding the fact, that a lot of money and waste could be saved by using the sparkling water maker.

4 Comparison of homemade sparkling water and bottled sparkling water

4.1 Costs

To analyze the price of water, we compared the expense of bottled sparkling water and tap water.

4.2 Research of homemade sparkling water price

We define the costs of sparkling water that is made with a sparkling water maker as the sum of the acquisition cost of the device, the cost of the refilling of the carbon dioxide cylinder and tap water costs, including the sewage costs.

The acquisition cost of a sparkling water maker, which usually comes with glass bottles and a carbon dioxide cylinder, varies between 50 and 150 euros, depending on brand and model. [1]

On average, refilling a carbon dioxide cylinder in a supermarket costs 8 euros. According to the manufacturer, one fully charged cylinder is enough for making 60l of sparkling water. [1]

In Germany, the tap water and sewage cost vary greatly depending on the region. One cubic meter of tap water in Stuttgart costs 2.82 euros [2]. The sewage cost is at 1.69 euros per cubic meter of water. [3]

Table 1: Cost of Carbon dioxide, tap water and sewage in euro per cubic meter/per liter

	Carbon dioxide	Tap water	Sewage
Per cubic meter	≈133.33	2.82	1.69
Per liter	≈0.1333	≈0.0028	≈0.0017

In the following equation the prices of carbon dioxide, tap water and sewage for one liter are summed up:

$$0.1333+0.0028+0.0017= \underline{0.1378} \quad (1)$$

If purchase costs are not included, one liter of sparkling water made with a sparkling water maker costs about 0.1378 euro (Eq.(1))

4.3 Research of bottled water price

To get a more precise result of the costs of bottled sparkling water, it is important to calculate an average price.

To do so, we researched the water price per liter of the ten best-known water labels at our school. These were Gerolsteiner Classic, Ensinger Sport Classic, Schwarzwald Sprudel Classic, Saskia Classic, Quellbrunn, Vilsa, Apollinaris, Adelholzener, Ja! Classic and Teinacher Classic.

Another brief investigation resulted in the costs per liter of the labels, which are Gerolsteiner Classic: 0.86€; Ensinger Sport Classic: 0.73€; Schwarzwald Sprudel Classic: 0.47€; Saskia Classic: 0.13€; Quellbrunn: 0.13€; Vilsa: 0.50€; Apollinaris: 0.51€; Adelholzener: 0.61€; Ja! Classic: 0.13€; Teinacher Classic: 0.93€ [4].

Then we calculated the average price in the following equation:

$$(0.86€ + 0.73€ + 0.47€ + 0.13€ + 0.13€ + 0.50€ + 0.51€ + 0.61€ + 0.13€ + 0.93€) / 10 = 0.49€ \quad (2)$$

We got an average price of 0.49€ per liter for bottled sparkling water (Eq. (2))

4.4 Results of costs

Due to the results from the last time's research, we could compare the price of bottled sparkling water and tap water. Since one liter of tap water including the needed amount of carbon dioxide costs 0.1378€ it is almost 3.5 times cheaper than buying bottled sparkling water if purchase costs are not included.

To get a better idea of the difference, we extrapolated the costs for one year.

The average person in Germany drinks about 141.7 liters of bottled water per year. [5] This costs about 69.43€ per year, as seen in Eq. 3

$$0.49€ \text{ x } 141.7 \text{ l} = 69.43€ \quad (3)$$

However, if you did not buy the water bottles and would instead drink homemade sparkling water, you would pay 19.53€ for the 141.7 liters per year, to which Eq. 4 refers.

$$0.1378€ \text{ x } 141.7 \text{ l} = 19.53€ \quad (4)$$

This is a difference of 49.9€ as seen in Eq. 5:

$$69.43€ - 19.53€ = 49.9€ \quad (5)$$

Nevertheless, this is only the price for just the water. For a precise comparison of the costs, we still had to contrast the final costs with the expenses of the purchase of a sparkling water maker.

In the following, the prices will be compared by taking an average family of two adults and two kids as an example. Each of them drinks about 1.5-liter of carbonated water per day so in total the average daily water consumption is about 6 liters of sparkling water.

Table 2: Comparison of costs over different time spans

Time	Bottled sparkling water	Sparkling water maker made sparkling water (without purchase costs)	Sparkling water maker made sparkling water + 100 euro purchase costs
Costs for 1 Day	2.94 euro	0.83 euro	100.83 euro
Costs for 1 week	20.58 euro	5.79 euro	105.79 euro
Costs for 1 month	88.20 euro	24.80 euro	124.80 euro
Costs for 3 months	124.80 euro	74.40 euro	174.40 euro
Costs for 6 months	**249.60 euro**	148.80 euro	**248.80 euro**
Costs for 1 year	1058.40 euro	297.65 euro	397.648 euro
Costs for 2 years	2116.8 euro	595.3 euro	695.3 euro

As can be seen in this table, after 6 months the costs of consumed bottled water are almost as high as the costs of sparkling water maker made sparkling water, including the average purchase costs (100 euro) of this device. As a conclusion we can say that the sparkling water maker has amortized after six months of use.

4.5 Limitations

However, this example does not quite represent reality because an average person in Germany consumes about 141.7 liters of bottled water a year. In this example one person consumes about 540 liters of sparkling water per year. But since 60% of the households of our school prefer sparkling water, we have simplified our calculations. The importance of saving money can be shown in the results.

5 Effects on environment

If sparkling water makers are used, one's own Carbon Footprint is effectively reduced. The independent study by the Carbon Trust showed that using sparkling water makers causes around 80% less greenhouse gases than purchased water in PET bottles.[6]

That is due to factors like transportation and production of water bottles.

5.1 Research of carbon dioxide emissions

For us, it was also important to compare ecological aspects in the project. To compare bottled sparkling water which is bought, and tap water, which is used with a sparkling water maker, we had to analyze the carbon dioxide emissions.

We started by investigating the water buying behavior at our school. The results of our survey were, that 47% of the households at our school buy their water. Another 79% of these households that buy their water, drive by car to get the water. When the water is bought by driving to a supermarket or specialized beverage supermarket, carbon dioxide emissions are released which could be prevented by either not driving with a car or not buying water bottles and using tap water instead.

Due to the fact that carbon dioxide is also used to carbonate tap water we wanted to figure out, how much less carbon dioxide emissions is released and which way of drinking sparkling water is more eco-friendly.

We researched the average carbon dioxide emissions for diesel and petrol cars and calculated the average emissions of the different car types, such as small cars, mid-range cars and large executive cars (Table 3).

Table 3:Average carbon dioxide emissions of a car in kg per 100 km (fuel consumption in liter) [7]

	Road traffic	B-road	Motorway
Petrol engine (models since 2011)			
Small car	18 (7.3)	13 (5.1)	17 (6.9)
Mid-range car	25 (8.7)	14 (5.7)	19 (7.4)
Top-of-the-range car	32 (12.6)	22 (8.7)	28 (11.1)
Diesel car (models since 2001)			
Small car	14 (4.5)	10 (3.1)	13 (4.1)
Mid-range car	21 (6.8)	15 (4.7)	16 (5.2)
Top-of-the-range car	28 (8.9)	19 (6.2)	26 (8.5)

The average carbon dioxide emissions per 100 kilometers are 25 kg for petrol cars (Eq. 6) and 21 kg for diesel cars (Eq. 7)

$$(18\ \text{kg} + 25\ \text{kg} + 32\ \text{kg}) / 3 = 25\ \text{kg} \quad (6)$$

$$(14\ \text{kg} + 21\ \text{kg} + 28\ \text{kg}) / 3 = 21\ \text{kg} \quad (7)$$

The average carbon dioxide emissions per kilometer are 0.25 kg for petrol cars (Eq. 8) and 0.21 kg for diesel cars (Eq. 9)

$$25\ \text{kg} / 100 = 0.25\ \text{kg per kilometer} \quad (8)$$

$$21\ \text{kg} / 100 = 0.21\ \text{kg per kilometer} \quad (9)$$

After this, we reviewed how long the households at our school need to buy their water and then calculated the average distances (Eq. 10.1; 10.2; 10.3) and the average distances per month (Eq. 11.1; 11.2; 11.3). For this, we divided them into three different categories for how long they need to get the water: less than 5 minutes, 5-10 minutes and more than 10 minutes. The survey yielded that the households drive about three times per month by car to purchase the bottled sparkling water. To calculate the average distance, we assumed that the cars drive at about 40 km/h, which is the average speed allowed in our city, Stuttgart.

$$5\ \text{min} \triangleq 300\text{s}$$

$$40\ \text{km/h} \triangleq 11.1\ \text{m/s}$$

$$300\ \text{s} \times 11.1\ \text{m/s} = 3.3\ \text{km} \quad (10.1)$$

$$(5\ \text{min} + 10\ \text{min}) / 2 = 8\ \text{min}$$

$$8\ \text{min} \triangleq 480\ \text{s}$$

$$480\ \text{s} \times 11.1\ \text{m/s} = 5.3\ \text{km} \quad (10.2)$$

$$15\ \text{min} \triangleq 900\ \text{s}$$

$$900\ \text{s} \times 11.1\ \text{m/s} = 13.3\ \text{km} \quad (10.3)$$

$$3.3\ \text{km} \times 3 = 9.9\ \text{km} \quad (11.1)$$

$$5.3\ \text{km} \times 3 = 15.9\ \text{km} \quad (11.2)$$

$$13.3\ \text{km} \times 3 = 39.9\ \text{km} \quad (11.3)$$

Next, we estimated the carbon dioxide emissions per month for both fuel types and each different average distance (Eq. 12)

$$9.9\ \text{km} \times 0.25\ \text{kg} = 2.475\ \text{kg}$$

$$9.9\ \text{km} \times 0.21\ \text{kg} = 2.079\ \text{kg}$$

$$15.9\ \text{km} \times 0.25\ \text{kg} = 3.975\ \text{kg}$$

$$15.9\ \text{km} \times 0.21\ \text{kg} = 3.339\ \text{kg}$$

$$39.9\ \text{km} \times 0.25\ \text{kg} = 9.975\ \text{kg}$$

$$39.9\ \text{km} \times 0.21\ \text{kg} = 8.379\ \text{kg} \quad (12)$$

This is a total average of 5.037 kg carbon dioxide emissions in one month (Eq. 13)

$$(2.475\ \text{kg} + 2.079\ \text{kg} + 3.975\ \text{kg} + 3.339\ \text{kg} + 9.975\ \text{kg} + 8.379\ \text{kg}) / 6 = 5.037\ \text{kg} \quad (13)$$

Because we wanted to compare the long-term ecological benefits and could only compare the carbon dioxide emissions with the sparkling water maker carbon dioxide tank in one year, we estimated the carbon dioxide emissions per year (Eq. 14)

$$2.475 \text{ kg} \times 12 = 29.7 \text{ kg}$$

$$2.079 \text{ kg} \times 12 = 24.948 \text{ kg}$$

$$3.975 \text{ kg} \times 12 = 47.7 \text{ kg}$$

$$3.339 \text{ kg} \times 12 = 40.068 \text{ kg}$$

$$9.975 \text{ kg} \times 12 = 119.7 \text{ kg}$$

$$8.379 \text{ kg} \times 12 = 100.548 \text{ kg} \quad (14)$$

Then we also calculated an average and got the result of 60.44 kg of carbon dioxide emissions per year (Eq. 15)

$$(29.7 \text{ kg} + 24.948 \text{ kg} + 47.7 \text{ kg} + 40.068 \text{ kg} + 119.7 \text{ kg} + 100.548 \text{ kg}) / 6 = 60.44 \text{ kg} \quad (15)$$

Yet it is important to say that these numbers are averages and can differ from individual to individual.

5.2 Results of carbon dioxide emissions

Especially nowadays, carbon dioxide emissions caused by cars are an important factor regarding environmental problems such as climate change. Reducing carbon dioxide emissions is a key objective not only in fighting climate change but also in minimizing air pollution in larger cities.

Hence, the calculation of the average annual carbon dioxide emissions caused by cars for grocery shopping are of importance. The calculated emissions per year of 60.44 kg show that not driving with your car to buy water bottles is eco-friendlier and an individual can save these emissions. It would be better if the purchase of carbonated water is made by taking public transport, riding a bike or walking. Nevertheless, the best alternative would be to not buy any bottled carbonated water at all but rather use tap water and carbonate it yourself.

By doing so individuals at our school can minimize their ecological footprint.

5.3 Research of carbon dioxide tanks from sparkling water maker

To comprise all aspects of carbon dioxide emissions and usage, we also wanted to figure out how the manufacturer get their carbon dioxide for the tanks.

Therefore, we wrote emails to 10 different producers of sparkling water makers to ask them about their carbon dioxide tanks. Those 10 companies were My Sodapop, Sodastream, Soda-Magic, Aarke, Sodatrend, Wassermaxx, Levivo, Isi, bwt-aqua and Pearl. The manufactures were chosen randomly.

The emails contained questions about how the companies produce the carbon dioxide and where it comes from.

5.4 Results of carbon dioxide tanks from sparkling water makers

Unfortunately, only 4 of the 10 companies answered our email. Moreover, they were not very helpful. One company could not send us any information about their carbon dioxide purchase, because it´s a “company secret” which they are not allowed to tell.

The second producer said they, too, can´t answer our questions but named no reasons for that.

The other two answers were also perfunctory. One of them gets its carbon dioxide from “internationally known gas suppliers” and the other one from “a natural source carbon acid”.

We have not received any other information about the production of the carbon dioxide for the tanks and since the obtained information was not clear enough to work with, we unsuccessfully dropped the research of carbon dioxide tanks of sparkling water makers.

5.5 Hazard of single-use plastic

Among the participants of our survey about 60% are buying their drinking water in plastic bottles. Many of them are single-use PET bottles. Although Germans return their deposit bottles to the supermarket, and drop glass bottles at public collecting points and most plastic bottles can be recycled, only a small amount is recycled. Collecting does not mean that the plastic is recycled. Experts assumed that only 38 percent of the collected plastic was actually recycled. [8]

The reason for that is that there are a lot of disadvantages of recycling. It is very expensive, the recycled products are not durable and it requires a lot of energy.

Furthermore, there is a lack of safety in recycling sites for the workers as well as for the environment because it often results in mass pollution. [9]

Moreover, there is a hard implement on a large scale because recycled products can be manufactured only if larger companies adapt to the environmentally friendly recycling process.

The other 62% of plastic waste that was not recycled ends up in landfills where plastic is incinerated producing unhealthy and climate-changing gases.

The major industrial nations, including Germany, export a large proportion of their plastic waste to South East Asia. As these countries lack functioning recycling systems, the waste often ends up in landfills, from where it is eventually discharged into the sea via wind or rivers. [10]

This results in huge garbage patches floating in the sea. Plastic decomposes completely only after 500 years.

That is a major problem because the plastic in the ocean is very hazardous to marine life.

Larger animals are endangered by mechanical injuries. Often sea animals and seabirds are strangled by plastic loops.

Furthermore, the wave motion and solar radiation cause the plastic floating in the sea to disintegrate into smaller and smaller pieces over time. Whales, robes, seagulls and other animals confuse the plastic parts with food, eat them and eventually die an agonizing death. In conclusion, the consumption of one-way-PET-bottles should be avoided as a contribution that everybody can accomplish to minimize this environmental problem.

5.6 Reusable bottles

Another option is to purchase water in reusable glass and plastic bottles.

Glass bottles can be refilled up to 50 times, while reusable PET-bottles can still be filled up to 20 times. But the main advantage of reusable plastic bottles is that they weigh less, so that less crude oil is used during transport than with glass bottles. Environmentally conscious consumers should therefore always opt for returnable bottles, preferably made from plastic, when buying beverages. Less waste is produced, while raw materials are conserved. [12]

Most sparkling water makers are sold with glass bottles, which can be used for an unlimited time. You can also choose reusable PET-bottles. From the moment of purchase they can be kept for about 3-4 years. After that they have to be bought again, which means additional costs for the customer.

If you buy sparkling water in the supermarket, reusable PET-bottles are the most environmentally friendly. Plastic disposable bottles should be avoided at all costs. For a sparkling water maker, the glass bottle would be the most environmentally friendly choice in the long-term perspective.

6 Effects on human health

First of all, bottled water is usually bought in packages of large quantities. To transport, carry and to lift those heavy bottles it takes a lot of strength and energy which could lead to health damages on the body (e.g. low-back pain). If you are using a sparkling water maker at home you will no longer be at risk. SodaStream uses this advantage for advertising purposes. Their slogan is: “Einfach sprudeln, statt schwer schleppen”[11] in English: “Just gush instead of haul”/”Simply carbonating instead of heavy hauling”.

Furthermore, the plastic in the oceans is not only a danger to sea life but also to human health. The microplastic enters the body through the consumption of marine animals. The consumption of fish has so far been classified as less of a concern, as fish themselves tend to absorb microplastics via the stomach, which is removed before consumption. Whether fish also carry plastic in their muscle mass has not yet been sufficiently researched. On the other hand, the consumption of other marine animals such as mussels or shrimps is of greater concern because the small plastic particles can pass directly through the cell membranes of these marine animals. So when eating marine animals, humans ingest the plastic.

The problem with plastic is that it often contains plasticizers. It is not clear to what extent they can be harmful to human health. However, there are fears that plasticizers may, for example, impair the function of the thyroid and pancreas and, under certain circumstances, the ability to reproduce. Even more drastic are the fears regarding the substance bisphenol-A (BPA). BPA is a chemical used in the plastics industry to lace plastic, making it cheaper.

The structure of the substance is very similar to a human hormone and can, therefore, cause confusion in the body and have a negative effect on hormone balance. In the long term, this can promote hormone-related diseases. Of particular concern is that hormones, even in extremely low doses, can have serious consequences for human health. [13]

Another point is that bottled water often contains poisonous chemicals from the PET-bottles themselves. Due to heat toxic substances like Antimony is leaking into the water [8]. Therefore, it is safer to drink sparkling water that is made with fresh tap water because tap water in Germany has high quality and is controlled regularly and the origin of tap water is more transparent than of bottled water.

Another point is that many believe that bottled water contains minerals, that are apparently important for the body, which are not present in tap water. But those are not needed by the body and they cannot be processed very well.

6.1 Results of Comparison of homemade sparkling water and bottled sparkling water

All in all, if homemade sparkling water is compared with bottled sparkling water, you can see many advantages for using the sparkling water maker or rather to stop buying bottled water. First of all, if you use the sparkling water maker for over 6 months, a lot of money can be saved. According to our calculations, the longer it is in use, the more money you save. After 2 years of use you will save at least 1400 euros, assuming that each person drinks 1.5 liters of sparkling water a day. Additionally, there are 80% fewer greenhouse gases due to not driving to supermarkets. You can minimize your ecological footprint by not driving by car and buy bottled water and can save up to 60.44kg of carbon dioxide emissions. Another point is that with one carbon dioxide cylinder up to 60 one liter single-use plastic bottles are saved using a sparkling water maker. This results in less contribution to the plastic pollution.

Furthermore, tap water, which is used for homemade sparkling water with sparkling water makers, does not contain unnecessary minerals and there are no toxic chemicals.

7 Conclusion

As the survey has shown, only a small number of households know about the benefits a sparkling water maker can have. Also, one could see that the ecological impacts of buying water are recognized by some of the households, since they are buying glass and not plastic bottles as well as they are willing to drive to a nearby beverage trade.

The next step for these households could potentially be to get a sparkling water maker themselves in order to minimize their ecological footprint even more.

Overall a sparkling water maker can minimize one´s ecological footprint by reducing the amount of emissions, plastic waste and waste of resources like glass and fossil oil. Additionally, the expenditure on sparkling water can be minimized and your health is not at risk of damages from consuming toxic chemicals or lifting heavy bottles. Furthermore, you save time because you don't have to go water shopping.

However, drinking tap water would be even more eco-friendly. It is our next step, combined with the results of the 2018 research, to educate the students and their families at our school, that tap water or a sparkling water maker device is beneficial in many ways. First of all, it saves economic costs for the household itself, but more important is the fact that its sustainably preserves the earth.

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