

Physico-Chemical Analysis of Packaged Drinking Water -A Comparative Study

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ABSTRACT

About thirty years back there was no existence of packaged drinking water but today packaged drinking water is the essential part of the market because of its stable growth and shelf life both globally and locally. Packaged Drinking water is any bottled water which is obtained from natural spring, well water or municipal supplies to this water chemicals and minerals may or may not be added, this is then sold for business or domestic uses all across the globe in unhampered, sealed, and clean containers. This water is subjected to many local and global standards which must be followed for safe drinking purposes. In this research a comparative analysis was done to access the quality level of the packaged drinking water available in the market.

Keywords: Packaged drinking water, Physico chemical analysis, Comparative study.

Introduction: The market forecast for 2013 predicted \$94.2 billion value of this industry which has an increase of 41 % since 2007. This reveals an ever increasing demands for numerous consumers all across the globe. [1]

The journey of bottled water industry began in 19th century when the Ricker family of Maine bottled and sold the water. This small initiative grew and led to this rise of this industry. The medicinal properties of spring water which was initially bottled without any knowledge about the minerals it offered soon came into notice; this became Poland Springs Water Company.

Keeping in view the success of the Poland Company many new companies came into existence in 1905 like Ozarka Spring Water Company of Eureka Springs. Since then there was no looking back for this industry. Now there are hundreds of different brands of Packaged Drinking Water available all across the globe. Ozarka and Poland are both owned by Nestle now and are a part of their reputed 75 different water brands [2]

The real milestone for this industry was when the company named **Vittel** launched the first plastic bottled water in the world in 1968. This revolutionised the way people used to consume bottled water in the world. France, Germany and Europe became the most stable players in the market [3]

Bottled water became slowly more acceptable because tap water in certain countries was either not found or not potable. These were the main reasons why bottled water came into being.

Indian bottled drinking water industry is driven by the events of unpredicted water shortage and health consciousness that has started to develop in the people.

The market is at 1,000 Crore and has a growth of 40 %. It is expected to reach 4,000 to 5,000 Crore that is an increase of 33 % in the market. Today round about 200 different brands of bottled water are present and among them 80 % are local in nature. Indian is 10th largest bottle manufacturer in the world.

Growth of Indian Bottled Water Industry

Year	Water Produced (Million cases)
1990	2.3
1992	2.7
1994	3.6
1996	4.8
1998	15.9
2000	36
2002	45.5
2004	67.4
2006	98
2008	112.7

2010	126.4
2012	142.4
2014	152.4
2015	168.4

Source: infochangeinindia.org.indiastat.com

The market of bottled water is dominated by certain players from past few years since it is very competitive. The main marketing competition among the players is that of packaging and attractive labelling which gathers them huge consumer base. The main market share is that of Bisleri International which is 40 %, next comes Kinley (around 25 %) and then Aquafina (10 %) rest is followed by the local market players in the market (20-25 %) [10]. One of the great ways developed by Parle Agro and PepsiCo is that of capacity enhancement which the only way of surviving the competition is.

Water Regulation in India: The packaged drinking water is solely managed by the Bureau of Indian standards (BIS) in association with the Health Ministry .The rules are formulated by PFA. The main objective was to come up with the collaborated act and legal requirements for allowable limits in the packaged drinking water. [13]

For packaged drinking water BIS-14543 and for natural mineral water BIS-13428 is to be followed. The packaging and labelling requirements are all covered in the same. It is mandatory to have the BIS mark on the bottled water and follow the requirements set by the standard agency for quality water intake of the consumers. The packaged drinking water industry to be licensed and setup is all mentioned in the 14543 standard and the audit for the same is done as per the required standards.

Materials and Methods: This research deals with the comparative Physico chemical analysis of the Bottled water available in the state of Jammu and Kashmir (Kashmir division). Following are the methods and techniques adopted to have an exhaustive coverage of this topic. The research technique for the wet lab work is as follows:

Objectives of the Study: Research design for Wet lab work

1. To study the Physico-chemical analysis of the packaged drinking water.
2. To perform a comparative analysis of the top ten leading bottled water companies of the valley as per consumer preference.
3. To perform a comparative analysis of the source water of the two packaged drinking water companies in the range of 100 meters in the light of BIS 10500 as a set standard for licensing.
4. To evaluate the samples as per FSSA 2011 Regulation (Packaging and labelling) and BIS 15410 for packaging and labelling requirements for the sample and interpret the results for the same
5. To interpret the results in the light of BIS 14543 (PDW), BIS 15410 (P&L), BIS 13428(NMW) and BIS 10500 (Source water).

Limitations of the Study

1. Performance of the limited quality analysis tests.
2. Evaluation of only those parameters that are commonly found in the source water of the area.
3. Availability of the limited source water samples

Selection of samples and Geographical area of study

The samples were collected on pure consumer preference of the bottled water. This consumer preference was analysed by the consumer buying behaviour in the retail and wholesale markets by conducting face to face discussions with the retails and wholesale owners. The most preferred top ten brands were selected for analysis. The location was restricted to Srinagar, Jammu and Kashmir.

Research Framework: The entire wet lab work (analysis and comparative testing) was done in the light of the BIS 14543 manual. The methods and procedures used in the analysis and testing were as per Annexure 11 of the manual and the results were compared with the Annexure 10 of the BIS manual.

Keeping in view the Food Safety and Standards act 2011 regulation for packaging and labelling, the same samples were subjected to detailed study for the parameters as per the regulation. The samples were also studied Under BIS 15410 (standard for Packaging and labelling).

Data editing and Statistical Tools: Simple measurement by central tendency was done and tools used were:

- Percentage calculation: this is used to give a certain percent value for a data and represents the data in a better form.
- Mean is the main or the central value of the probability distribution.

Findings and Discussions: This research brings into limelight some serious areas of concern regarding the packaged drinking water quality available in the market and the consumer acceptability of the same. It also focuses on the packaging and labelling rules which are to be followed by the multiple companies to keep their product up to the mark.

Wet Lab work: Each of the samples was tested for Ph, hardness, colour, TDS, alkalinity, chloride, calcium, magnesium, Odour and taste. Apart from these qualitative and quantitative parameters the samples were also tested for many packaging and labelling requirements that are to be there for the certifications. Two of the source water samples were also tested for the same parameters.

The key findings of the research are discussed below with interpretation as per BIS:

Key findings:

1. **Higher Magnesium Content In 41 % Of the Samples:** It was found that 41 % of the samples had a higher magnesium content as prescribed by BIS 14543 That is ought to be **30 ppm** max in packaged drinking water and as per BIS 13428 **50 ppm** max for natural drinking water. Also as per BIS 10500 the max magnesium content for source water to be selected as per licensing requirement is 30 ppm. These set standards are found to be violated in the 41 % of the samples collected.

High magnesium content in the body may lead to health issues like; People with kidney disease are not able to expel magnesium from body therefore can cause, hypertension, confusion, muscle weakness, and coma. It is therefore necessary to expel the undesired magnesium content from the body to live a healthy life. [16].

2. **33% of the samples have not agreeable taste:** It was found after meticulous sensory evaluation that 33% of the samples had a poor taste not as per the required standards fixed for the bottled water and source water.

Taste is one of the most important factor for the bottled water to improve its consumer acceptability. If taste is not up to the mark the product may easily be rejected on the market shelves. Taste of the product is determined by the hardness it has, the Ph it contains, the source from which it is taken and the rest of the minerals it posses.

3. **1% of the samples had acidic Ph:** Results revealed that a sample was also found to be acidic and in the decreasing Ph condition when tested. The Ph for bottled water is supposed to be **6.5-8.5** on a regular basis the sample was found to have a decreasing (un stable) **Ph of 6.01 and decreasing**. This acidic water can lead to leaching in the pipes and leaching atoms and ions from filters and other fittings causing the mineral content of the water to increase because of that the hardness of water may increase causing foul odour and poor taste.

4. **40% of the sample had a wrong product description and deceptive source details.** It was found that 40 % of the samples collected had a poor description that was mainly deceptive towards consumers as per FSSAI 2011 regulation for packaging and labelling. These false and misleading claims, mislead the consumer towards the real source of water that is ground water. As per the food safety and standard regulation 2011 packaging and labelling regulation 2.2.1.3 i.e.

Pre packaged food shall not be described or presented on any label or in any labelling manner that is false, misleading or deceptive or is likely to create an erroneous impression regarding its character in any respect. Those violating it are subjected to a penalty of three lakh as per section 52 of FSSA 2006

5. **80% of the sample had FSSAI logo in a wrong format:** As per food safety and standards act (packaging and labelling) regulation 2011 Reg. 2.2.1.7 the primary display panel has to have the FSSAI Logo in the following format:

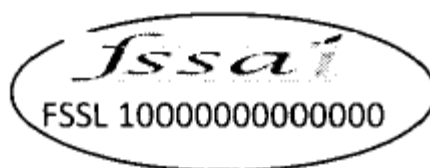


Fig 1: Fssai licence format

Almost 80 % of the samples collected had the logo in the wrong format
WET LAB COMPLETE DETAILS

Physico-chemical Quality Attributes										
Date	Sample	pH	Color	TDS	Acidity	Alkalinity	Taste	Odor	Calcium	Magnesium
Day 1 (After opening the seal)	Sample A	6.89	Clear	100	40	79	Agreeable	Agreeable	8.010	10.233
Day 2 (24 hours after opening)	Sample A	6.88	Clear	100	37	78	Agreeable	Agreeable	7.2	8.8
Day 3 (48 hours after opening)	Sample A	6.89	Clear	100	38	77	Agreeable	Agreeable	8.010	10.233
Average		6.8867	Clear	100.333	38.33333333	78	Agreeable	Agreeable	7.74	9.744
Day 1 (After opening the seal)	Sample B	6.52	Clear	29	15	19.8	Agreeable	Agreeable	8.010	1.458
Day 2 (24 hours after opening)	Sample B	6.52	Clear	29	15	19.8	Agreeable	Agreeable	8.010	1.458
Day 3 (48 hours after opening)	Sample B	6.52	Clear	29	15	19.8	Agreeable	Agreeable	8.010	1.458
Average		6.52	Clear	29	15	19.8	Agreeable	Agreeable	8.010	1.458
Day 1 (After opening the seal)	Sample C	6.87	Clear	90	40	78	Agreeable	Agreeable	18.4	30.24
Day 2 (24 hours after opening)	Sample C	6.87	Clear	90	40	78	Agreeable	Agreeable	18.4	30.24
Day 3 (48 hours after opening)	Sample C	6.87	Clear	90	40	78	Agreeable	Agreeable	18.4	30.24
Average		6.87	Clear	90	40	78.33333333	Agreeable	Agreeable	18.4	30.24
Day 1 (After opening the seal)	Sample D	7.3	Clear	78	22	40	Agreeable	Agreeable	8.010	12.188
Day 2 (24 hours after opening)	Sample D	6.5	Clear	79	19	40	Agreeable	Agreeable	8.017	12.184
Day 3 (48 hours after opening)	Sample D	6.5	Clear	78	19	40	Agreeable	Agreeable	8.010	12.188
Average		6.77	Clear	78.3333	20.33333333	40	Agreeable	Agreeable	8.009	12.187
Day 1 (After opening the seal)	Sample E	7.4	Clear	80	10	70	Agreeable	Agreeable	30	54
Day 2 (24 hours after opening)	Sample E	7.4	Clear	80	10	70	Agreeable	Agreeable	30	54
Day 3 (48 hours after opening)	Sample E	7.4	Clear	80	10	70	Agreeable	Agreeable	30	54
Average		7.4	Clear	80	10	70	Agreeable	Agreeable	30	54
Day 1 (After opening the seal)	Sample F	6.89	Clear	154	29.8	130	Agreeable	Agreeable	7.8	34.12
Day 2 (24 hours after opening)	Sample F	6.89	Clear	154	29.8	130	Agreeable	Agreeable	7.8	34.12
Day 3 (48 hours after opening)	Sample F	6.89	Clear	154	29.8	130	Agreeable	Agreeable	7.8	34.12
Average		6.89	Clear	154	29.8	130	Agreeable	Agreeable	7.8	34.12
Day 1 (After opening the seal)	Sample G	6.88	Clear	18	10	40	Agreeable	Agreeable	7.2	15.5
Day 2 (24 hours after opening)	Sample G	6.88	Clear	18	10	40	Agreeable	Agreeable	7.2	15.5
Day 3 (48 hours after opening)	Sample G	6.88	Clear	18	10	40	Agreeable	Agreeable	7.2	15.5
Average		6.88	Clear	18	10	40	Agreeable	Agreeable	7.2	15.5
Day 1 (After opening the seal)	Sample H	6.88	Clear	59	33	43	Bitter	Agreeable	9.6	15.8
Day 2 (24 hours after opening)	Sample H	6.88	Clear	59	33	43	Bitter	Agreeable	9.6	15.8
Day 3 (48 hours after opening)	Sample H	6.88	Clear	59	33	43	Bitter	Agreeable	9.6	15.8
Average		6.88	Clear	59	33	43	Not agreeable	Agreeable	9.6	15.8
Day 1 (After opening the seal)	Sample I	7.16	Clear	161	120	130	Agreeable	Agreeable	30.4	123.79
Day 2 (24 hours after opening)	Sample I	7.16	Clear	161	120	130	Agreeable	Agreeable	30.4	123.79
Day 3 (48 hours after opening)	Sample I	7.16	Clear	161	120	130	Agreeable	Agreeable	30.4	123.79
Average		7.16	Clear	161	120	130	Agreeable	Agreeable	30.4	123.79
Day 1 (After opening the seal)	Sample J	6.54	Clear	10	N/A	10	Agreeable	Agreeable	N/A	N/A
Day 2 (24 hours after opening)	Sample J	6.5	Clear	10	N/A	10	Slightly Bitter	Agreeable	N/A	N/A
Day 3 (48 hours after opening)	Sample J	6.4	Clear	10	N/A	10	Slightly Bitter	Agreeable	N/A	N/A
Average		6.53333	Clear	10	N/A	10	Not agreeable	Agreeable	N/A	N/A

Fig 2: Physico chemical analysis of Sample- details

S.No.	BS Parameters: 5410 & 5453 for PDW	A	B	C	D	E
1	Container is tamper proof, impervious and light	ok	ok	ok	ok	ok
2	Type of Container	Bottle	Bottle	Bottle	Bottle	Bottle
3	Package is colorless and transparent	ok	ok	ok	ok	ok
4	No claim on the label	wrong product description	ok	ok	wrong product description	ok
5	Shelf life of the product is mentioned on the label	ok	ok	ok	ok	ok
6	Best Before Clearly mentioned	ok	ok	ok	ok	ok
7	Capacity of the container must be mentioned	ok	ok	ok	ok	ok
8	Date of manufacturing written in one straight line	ok	ok	ok	ok	ok
9	Has a lot batch no	ok	ok	ok	ok	ok
10	When batch no. need of D.O.M. unless on same date	N/A	N/A	N/A	N/A	N/A
11	Standard mark clearly made with proper dimensions	ok (BSI not FSSAI)	ok (BSI not FSSAI)	ok (BSI not FSSAI)	ok	ok (BSI not FSSAI)
12	Brand name mentioned	ok	ok	ok	ok	ok
13	Name of the product	ok	ok	ok	ok	ok
14	Name and full address of the processor	ok	ok	ok	ok	ok
15	Treatment of distribution	not mentioned	ok	ok	ok	N/A
16	Directions for storage	ok	ok	ok	ok	ok
Food safety and standards (FSSAI) Regulation, 2011						
17	packaging only in PET, PVC, PP, PET, PET and glass as per IS 1046, 1048, 1052, 1050	PET	PET	PET	PET	PET
18	The label should have hindi, english and devnagri script and other languages may follow	english	english	english	english and devnagri	english and French
19	No picture on the label which is misleading to take	ok	ok	ok	Snow clad Mountains	ok
20	Label should be held with the container tightly	ok	ok	ok	ok	ok
21	Contents should be legible	ok	ok	ok	ok	not proper devnagri
22	License number displayed in the FSSAI format	no	no	no	ok	not all French
23	List of ingredients if more than one added as per section 2.2.2	ok	ok	ok	N/A	ok
24	Nutritional information to be mentioned per 100ml if any	ok	ok	ok	N/A	not mentioned
25	20% of the product height as the PDP	ok	N/A	ok	ok	ok
26	Must have declaration of Packaged Drinking water	ok	ok	ok	ok	N/A
27	One time usability must have CRUSH THE BOTTLE AFTER USE	ok	ok	ok	ok	ok
28	Mineral water must have declaration NATURAL MINERAL WATER	N/A	N/A	N/A	N/A	ok
29	Claim to a place is prohibited unless the source is the same	claim made source not	ok	ok	wrong source	ok
30	Complete Address of the manufacturer	ok	ok	ok	ok	ok
31	storage conditions to be mentioned	ok	ok	ok	ok	ok
32	Consents	Mentioned PDW but Satisfactory	Satisfactory	Satisfactory	Not Satisfactory	Not Satisfactory

IS Parameters: 5400 & 10500 for PDW	F	G	H	I	J
Container is tamperproof, impervious and tight	o.k	o.k	o.k	o.k	o.k
Type of Container	Bottle	Bottle	Bottle	Bottle	Bottle
Package is colorless and transparent	o.k	o.k	o.k	o.k	o.k
No claim on the label	o.k	o.k	Wrong product Description	o.k	o.k
Shelf life of the product is mentioned on the label	o.k	o.k	o.k	o.k	o.k
Best Before/ Clearly mentioned	o.k	o.k	o.k	o.k	o.k
Capacity of the container must be mentioned	o.k	o.k	o.k	o.k	o.k
Date of manufacturing written in one straight line	o.k	not legible	o.k	o.k	o.k
Has a lot/ batch no	o.k	o.k	o.k	o.k	o.k
Water batch no instead of D.O.M unless on same date	N/A	N/A	N/A	N/A	N/A
Standard mark is clearly made with proper dimensions	Only BIS	only BIS	o.k	Only BIS	Only BIS
Brand name mentioned	o.k	o.k	o.k	o.k	o.k
Name of the product	o.k	o.k	o.k	o.k	o.k
Name and full address of the processor	o.k	o.k	o.k	o.k	o.k
Treatment of disinfection	o.k	o.k	o.k	o.k	o.k
Directions for storage	o.k	o.k	o.k	o.k	o.k
Packaging and standards (FSSAI Regulation, 2011)					
packaging only in PE, PVC, PP, PET, PET and glass as per IS 1546, IS 15112/52, 10510	PET	PET	PET	PET	PET
The label should have hindi, english and devnagri script and other languages may follow	english	english	english	english and urdu	english
No picture on the label which is misleading or false	o.k	o.k	o.k	Show Gird Mountains	o.k
Label should be held with the container tightly	o.k	o.k	o.k	o.k	o.k
Contents should be legible	o.k	o.k	o.k	o.k	o.k
License number displayed in the FSSAI format	no	no	o.k	no	no
List of ingredients if more than one added as per section 2.2.2	o.k	o.k	o.k	o.k	o.k
Nutritional information to be mentioned per 100 ml if any	o.k	not mentioned	not mentioned	o.k	o.k
20% of the product height as the PDW	o.k	o.k	o.k	o.k	o.k
Must have declaration of Packaged Drinking water	o.k	o.k	o.k	o.k	o.k
One time usable must have CRUSH THE BOTTLE AFTER USE	o.k	o.k	o.k	o.k	o.k
Mineral water must have declaration NATURAL MINERAL WATER	N/A	N/A	N/A	N/A	N/A
Claim to a place is prohibited unless the source is the same	o.k	o.k	deceptive source	o.k	o.k
Complete Address of the manufacturer	o.k	o.k	o.k	o.k	o.k
Storage conditions to be mentioned	o.k	o.k	o.k	o.k	o.k
Comments	Disinfectors	Disinfectors	Mentioned PDW but description of PDW	Disinfectors	Disinfectors

Fig 3: Labelling and packaging Requirements of Sample- comparative details

IS 10500:2012 Raw Water Specification										
Sample	Ph	Color	TDS	Hardness	Alkalinity	Taste	Odor	Calcium	Magnesium	Chloride
Bore well SAMPLE A	7.19	Not Acceptable	511/500	180/200	298/600	unacceptable	slightly poor	64.128/75	116/30	32.66/250
Bore well SAMPLE B	7.6	Not Acceptable	309/500	250/600	300/600	unacceptable	slightly poor	230/200	93/30	82.5/250

Fig 3: Source water comparison details

Conclusions: After the detailed analysis of the available brands, following points are recommended:

- It must be noted that the calcium and magnesium level are not generally kept under limits in a lot of samples. High magnesium water can lead to a lot of health issues pertaining to hypertension, confusion, muscle weakness, and coma. For kidney malfunction patients it is hard to expel magnesium from the body of the patients. Therefore care must be taken that no very hard water is packed in bottles to avoid any complaints regarding public health.
- In majority of the samples claim of water from a different source was made it must be made mandatory that the original source of water is mentioned so that the trust deficient in the consumers regarding the water source is erased and more consumers are able to enjoy the bottle water convenience. The local food safety authorities must act stern as per FSSA 2006 on the companies so that it sets a precedent for others claiming the same.
- Once the water hardness is brought under control it is responsible for the better taste of the companies in the market thus providing a good quality water to consumers who mainly select the water brand as per its sensory attributes. Bottled water that has no consistent mineral level changes its taste and odour with respect to time which is generally not acceptable for bottled water which may be stored with a broken seal for few days.
- During this research it was found that a lot of companies don't adhere to the proper licensing format of the FSSAI. It must be made mandatory by the local food safety agencies that the companies are made aware about the same so that the consumers can differentiate among the original license holders and the fake licences.

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Be a yardstick of quality. Some people aren't used to an environment where excellence is expected.

~ Steve Jobs