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Composition and Sensorial Characteristics of Tap and Bottled Drinking Water in Pakistan

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An attempt has been made to correlate the drinking water physiochemical characteristics and their sensorial implications with consumer's satisfaction and preferences. An interrelationship between consumption patterns and product development has also been studied. By using multi-variant statistical and conjoint analysis the demographic, psychological and personal behaviour have been magnified to understand the marketing critics behind an incremented usage of bottled water. This research reveals that sensorial acceptability is synergistically influenced by complex physiochemical composition. Furthermore the population of low income per capita's region have been given priority to health concern over taste as in a reason regarding bottled water usage. Moreover; willing to pay behaviour found differed by gender basis, they often display an identical mindset while purchasing bottled water throughout several conditions in spite of demographic variables. Managerial implications and suggestions for both bottled water producers and local water distributors for further advancement have been discussed.

Keywords: Physiochemical, Sensory, Correlations, Marketing, Preference, Perception.

INTRODUCTION

Providing the best ever product in strict competition atmosphere to consumer in accordance of needs is known as an art in scenario of food product development and marketing. Although in case of drinking water it has become more complicated as drinking water's sensorial attributes are difficult to characterize and identify in comparison to other food class.

Over the recent years, water suppliers have become increasingly aware of the need to understand the origins of consumer satisfaction with the taste and odor of water supplied to their homes [1]. Water can be drinkable as well as sensorially tolerable if it is in a very complicated form produced simply by selected and nicely balanced nutrients. A real top quality public water supplies are usually secure simply by restrictions, creatively unattractive taste-and-odor complications have brought about consumers looking for alternative, bottled water as well as tap water prepared simply by point-of-use filtration systems likewise producers are employing different technologies for production in instance filter, deionization, reverse osmosis and ozonation [2].

Bottled water an alternate of tap water is considered to be highly profitable due to low production cost, cheap raw material and high productivity. Because of aesthetic unappealing sensorial characteristics and health hazards issues associated with intake of contaminated tap water, the consumption rate of bottled water is drastically increasing in the world with different increment rates in spite of its excessively high price. Increase in bottled water consumption has boosted the bottled water industry and market trends show promising perspectives for the future. There are several studies highlighting the factors that influence the bottled water consumption in which major are organoleptics, health concerns and reliability; it may also vary among demographic locations [3], although the patterns seem to vary according to the region and country such variables include ethnic group, age, income, occupation and gender. Falahee and MacRae [4]; Lou *et al.* [5] have reported valuable research on consumption patterns, demographic characterization, consumer behaviours and sensorial attributes.

In marketing research and development a useful tool "conjoint analysis" is used to explore the consumer preferences among multi-attribute alternatives, which characterizes a product into a bundle of attributes and assigns levels for each attribute, the main object is to determine what combination of a limited number of attributes is most influential on respondent choice or decision making [6]. In present study we applied multi-attribute conjoint modeling to find out correlation between physiochemical in response to sensory attributes, consumption pattern and personal psychological behaviour by different demographic and marketing point of views.

EXPERIMENTAL

Sample collection: Commercially available bottled water (n = 3) were purchased randomly from three different vended locations and local tap water samples (n = 3) were taken from four local final output taps from Karachi. Data provided by producer *i.e.* expiry date and composition were recorded, details of bottled and tap water in terms of commercial and local identity are given in Table-1.

Phytochemical analysis: Total fifteen parameters having key importance in quality assurance of drinking water were measured namely; TDS and TSS by gravimetric method, TS by using formula TDS + TSS, boiling point by using mercury containing thermometer in paraffin medium, pH by pre calibrated JENWAY 3510 pH meter, electrical conductivity by using pre calibrated JENWAY 4510 conductivity meter, hardness by complexomtric titration keeping pH constant at 10, acidity by titrating against 5 mM NaOH [7], alkalinity by titrating against 10 mM H_2SO_4 [7], chloride by Mohr's argentometric titration method [7,8], nitrate by using double beam UV-2600 BMS spectrophotometer *via* taken absorbance at 220 and 275 nm for background correction [7], sulphate was determined by turbidity method using double beam UV-2600 BMS spectrophotometer *via* taken absorbance at 525 nm [7], sodium by AAnalyst-700 atomic absorption spectrophotometer in emission mode using air-acetylene flame and absorbance were recorded at 248.3 nm, AMC limit by pour plate technique on nutrient agar and coliforms limit by pour plate technique on Eosin-Methylene blue (EMB) agar [7].

Sensory analysis

Training of panelists: Approximately 25 students (semi trained) were selected as panelists during a training session was conducted to familiarize them from the objectives. Precautions were given about sensory analysis such as not to use any cosmetics, avoid to use tobacco products and not to make flukes during taking decisions, local tap water were given as taste bud cleanser.

Sensory evaluation: Samples were given to panelists in odor free paper cups and asked to rate samples on given sensory parameters *i.e*. odor (by sniff), after taste (sensation after swallowing), carbonation (bubbles during swallowing), appearance (by careful view), sound (during swallowing by inner ear drums), mineral quantity (by metallic taste on buds) and overall likeness (on overall quality), a usual 9 point hedonic ranking scale were used where 9 meant like extremely and 1 meant dislike extremely as described by Larmond [8].

Consumer perception and blind tests: A questionnaire was developed to access the consumer perception and drinking behaviours towards drinking water. In 1st section respondents were asked about demographic variables, habits, preferences, general thoughts, reason, frequency, identifying ability and satisfaction along with dissatisfaction reasons about their drinking water. In 2nd section respondents were asked to write down satisfaction and dissatisfaction reasons for liking or disliking one, identifying ability were accessed by asking the assessors as the tasted one sample was a bottled water sample or local tap water sample this was done by binomial scale yes/no. To access the ability of identifying mineralization assessors were asked to rate the mineralization of respective sample among other samples, identifying ability of assessors of their favourite brands were also determined by matching their favourite brand with their noted one, top most liked and top most disliked samples were determined by binomial scale liked/disliked. This method was developed by conjoin the methods reported by Sipos [2] and Lou *et al.* [5].

Willing to pay behaviour (WTP) and purchase intent (PI) factor assessment: Willing to pay behaviour (WTP) and purchase intent (PI) factor access through enquiry based questionnaire as suggested by Sipos [2] with diminutive development. Panelists were asked to define their will to pay for bottled water *versus* price increments by different ratios *i.e*. 10-50 %. Purchase intent was assessed by panelists responses, they were asked to pick up their decision driving factors that influence their preference at certain condition (taste, appearance, price, brand, certificate, award, prize winning, packaging, total solids, minerals, promotions, refundable, family or friends recommendations, origin, packaging unit, advertisement, availability) and at different events (*e.g*. home, during travel, at office, in institute, from restaurant, for routine use). Multiple choices were allowed.

Quality assurance: Proper quality assurance measures were applied to make sure the results trust-ability and integrity. All regents used were of analytical grade, double distilled deionized water was used throughout the research work. In order to avoid any contamination all glass wares were properly washed and dried in air circulated oven (EcoCell Einrichtungen-222, MedCentre). All measurements were carried out at ambient condition (25 °C, 90 % RH).

Statistical analysis: Data reported is the mean ± SD and range of three separated analysis done. Correlation and ANNOVA was evaluated using Minitab (Minitab; Ver 16.1.1) from Minitab, Inc., USA; TUKKY's HSD was used to compare means at 95 % significance level. Calculations were performed using Microsoft Excel (MS Office 2007; Ver 12.0.4518.1014) for Microsoft Windows (Microsoft Window XP Professional 3, Microsoft Corporation, Washington, USA).

RESULTS AND DISCUSSION

Total dissolved solids (TDS), total suspended solids (TSS) and total solids (TS): Higher TDS indicates contamination by natural or human activity and leads to poor water quality results in high degree irritating sensory and severe health problems depending on absolute casualty [5,9]. In general all concentrations were far below from any threshold level setup by concerned authorities of WHO [10], EU [11], PSQCA [12] and Ikem, Odueyungbo, Egiebro and Nyavor [13] of 1 g/L. In municipal samples (265.56-843.89 mg/L) TDS was present significantly higher than commercial samples (186.67-745.56 mg/L) also having nearby values in contrast with tolerance limits, this might be due to maximum contamination possibilities and less safety measures applied by local water distributors whilst commercial water kept safe in bottled containers that shielded product from any environmental or bacterial pestilence. Observed significance difference among samples indicates difference of production methods applied popular brands uses up-to-date production procedures as especially integrated membrane systems, comprising ultra-filtration and nano-filtration [5]. In relation with TDS other two variables TSS and TS have shown same behaviour, higher values observed in municipal samples (TSS; 463.89-680 mg/L, TS; 901.67-1352.22 mg/L) and lower values observed in commercial samples (TSS; 20.28-122.28 mg/L, TS; 73.34-851.28 mg/L).

Total dissolved solid posses significant strong positive correlation with TS (r = 0.762) > Cl^- (r = 0.635) > hardness (r = 0.631) > electrical conductivity (r = 0.595) > pH (r = 0.508) > alkalinity (r = 0.479) > SO_4^{2-} (r = 0.478). This observation agreed with Bhandari and Nayal [9] (reported positive correlation of TDS with TS, TSS and pH) and Vikal [10] (reported positive correlation of TDS with pH, electrical conductivity and alka-linity). In fact it is assured that TDS is summation of salts and biological matter that leads to increment in alkaline material and pH. Furthermore TDS posses negative correlation with carbonation (r = -0.271) > odor (r = -0.116), overall likeness (r = -0.14) that might be due to increase in pH, may be decrease the carbonation feelings also biological matter and salts can cause the offensive odors and bad mouth feel, same case reported by Kempster *et al.* [11] that rise in TDS can lead to unpleasant salty taste. Here we have little disagreement with Falahee and MacRae [1] that water with higher mineral content were like the best but in our data TDS showing negative correlation with overall likeness. Municipal water that having high mineral content was disliked and bottled water having low mineral content was disliked too although water having medium mineral content was liked as the best. Municipal samples averagely contain 568.19 mg/L TDS and commercial having 401.90 mg/L TDS; on sensory point of view municipal gets 5.09 and commercial gets 5.44 marks. Total suspended solids shares positive correlation with TS (r = 0.762) > AMC (r = 0.662) > acidity (r = 0.588) > SO_4^{2-} (r = 0.570) > Na (r = 0.520) > alkalinity (r = 0.487) > electrical conductivity (r = 0.453) and negatively correlation with after taste (r = -0.535) > mineral quantity (r = -0.472) > CAR (r = -0.442) > overall likeness (r = -0.410) > odor (r = -0.398) > pH(-0.052). This output is in partial agreement with Bhandari and Nayal [9] (reported Cl^- and TDS show positive correlation with TSS and in case of Na, SO_4^{2-} and electrical conductivity we get positive correlation). Total suspended solids shares negative correlation with carbonation and odor as TSS are macro species that can cause offensive odors and bad after taste that's why after effecting carbonation and odor it will lead to minimizing the overall likeness of water. As shown in Table-1, TSS values of municipal waters are significantly higher (avg. 566.39 mg/L) than commercial (61 mg/L) and due to this, it has got low marks (5.38) than commercial samples (5.83). Total solids share strong positive correlations with electrical conductivity (r = 0.723) > hardness (r = 0.677) > SO_4^{2-} (r = 0.690) > acidity (r = 0.664) > alkalinity (r = 0.659) > AMC (r = 0.619) > Cl^- (r = 0.595) > Col = Ecol (r = 0.564), it indicates that TS increases as alkaline salts increases and minimize the possibility of bacterial growth. Total solids posses significant negative correlation with carbonation (r = -0.462) and also with all sensory attributes as observed in case of TSS *i.e.* after taste (r = -0.387) > odor (r = -0.341) > overall likeness (r = -0.330) > mineral quantity (r = -0.226) > sound (r = -0.119) > appearance (r = -0.057). We conclude that TS increment is not in favour in any case of sensorial attributes it can lead to bad after taste, offensive odor, metallic taste, low attractive voice, bad appearance and also low overall acceptability. On average basis municipal samples have 1056.11 mg/L TS while commercial samples have 462.91 mg/L TS and overall acceptability of commercial samples are 0.34 marks higher than municipal samples.

Boiling point: Boiling point is the primary tool for indication of water quality index having standard value of 100 °C. Commercial samples having significantly low (averagely 100.33 °C; 94-109.33 °C) values than municipal samples (averagely 102.77; 97.67-107.67 °C). High boiling point of municipal samples are due to high TDS values while low boiling point of commercial samples indicates the volatile contamination and or excess removal of metallic ions during production and TS filtration [12].

Boiling point shows negative correlation with all parameters except from AMC (r = 0.074). Boiling points increase due to environmental contamination and cause the possibility of bacterial growth. Boiling point is showing significant negative correlation with pH (r = -0.538) > after taste (r = -0.532) > overall likeness (r = -0.464). In case of sensory markings commercial samples having low boiling point than municipal samples and having good markings on after taste, odor and overall likeness.

pH: The standard values of pH ranging from 6.5 to 8.5, water having low pH below than 6.5 posses sour and/or metallic taste while above than 8.5 indicates presence of high level alkali minerals and leads to bitter and/or alkaline taste [5,12]. In studied samples all are found in a narrow range (municipal; 6.66-7.53, commercial; 6.66-7.96). Unpopular brands having significantly low pH than popular and municipal samples that might be due to excess removal of TDS which leads to lowering the pH.

pH shares positive significant correlation with SO_4^{2-} (r = 0.625) > hardness (r = 0.635) > electrical conductivity (r = 0.598) > Na (r = 0.464)NO_3^- (r = 0.461) from sensorial attributes, it correlates positively with overall likeness (r = 0.333) > appearance (r = 0.271) > after taste (r = 0.251). Little coincide result represented by Gupta *et al.* [13] which showed positive correlation of pH with electrical conductivity and total alkalinity. Bhandari and Nayal [9] reported positive correlations between pH, Cl^-, SO_4^{2-} and hardness. pH contributed positively in all applied sensorial characteristics, pH values of both commercial and municipal samples are same on average basis.

Electrical conductivity: Electrical conductivity indicates the mobility of ions in a complex mixture of water environment, generally used to classify water for certain purpose [11]. European Union standard is set as 400 µs/cm, all municipal samples exceeded the EU limits with average of 805.33 µs/cm ranging 480.33-1589.33 µs/cm, while commercial samples namely Kinley, Natural, Al-Habib, Sprinkle, Spring Fresh, Sunlay, Mountain (578.67, 520.67, 466.66, 457.67, 473.33, 678.33 and 817 µs/cm, respectively) exceeded the limit while other samples values were found under the limits with an average of 303.92 µs/cm.

TABLE-1
PHYSIOCHEMICAL PROPERTIES OF TAP (FROM DIFFERENT LOCATIONS) AND BOTTLED (DIFFERENT BRANDS) WATER[a]

S. No.	Values	TDS (mg/L)	TSS (mg/L)	TS (mg/L)	Boiling point (°C)	pH	Electrical conductivity (µS/cm)	Hardness (mg/L)	Acidity (mg/L)
PSQCA[1]		1000			–	6.5-8.5	–	250	–
WHO[2]		1000			–	6.5-8.5	–	–	–
EU[3]		–			–	6.5-8.5	400	–	–
M1	Mean±SD	265.56±23.82	680.00±86.32	901.67±92.60	107.67±0.58	6.66±0.11	480.33±3.05	144±0.00	15.52±0.65
	Range	245-291.66	536.6-691.1	796.70-971.66	107-108	6.6-6.8	477-483	144-`144	14.76-15.90
	SC	ef	a	c,d	a,b	f	g	c,d,e,f	b,c,d
M2	Mean±SD	278..33±17.56	654.44±61.43	932.78±77.89	103.66±1.5277	6.96±0.05	559±2.00	146.66±2.31	15.71±3.12
	Range	261-296.67	585.0-701.7	846.61-998.34	102-108	6.9-7.0	557-561	144-148	13.63-19.31
	SC	e,f	a	b,c	c,d	d,e,f	e	c,d,e,f	b,c
M3	Mean±SD	885±105.99	467.22±110.88	1352.22±196.22	97.67±0.58	7.53±0.05	1589.33±4.50	228±20.78	29.34±1.73
	Range	788.34-998.33	358.3-585.0	1226.52-1578.33	97-98	7.5-7.6	1585-1594	204-240	27.83-31.24
	SC	a	b	A	e,f	b	a	a	a
M4	Mean±SD	843.89±48.57	463.89±98.90	1307.78±145.77	102±1	7.4±0.2	592.66±5.50	161.33±2.31	124±2.04
	Range	788.33-878.45	351.6-538.3	1140.0-1403.28	101-103	7.2-7.6	587-593	160-164	7.95-11.92
	SC	a	b	a,b	c,d	b,c	d	b,c	d,e,f
Aquafina	Mean±SD	272.22±34.69	22.67±3.24	294.89±35.08	101.33±0.58	6.93±0.05	233.33±1.15	61.33±1.15	4.35±0+0.32
	Range	233.3-300.0	20.16-26.34	254.83-309.67	101-102	6.9-7.0	232-234	60-62	3.97-4.54
	SC	e,f	c	g,h	c,d	d,e,f	k	h,i	g
Nestle	Mean±SD	402.78±49.45	27.78±6.94	430.56±42.63	102.33±0.58	7.06±0.11	379±12.28	135.33±2.31	7.57±1.18
	Range	356.6-396.7	20.00-33.43	390.0-475.0	102-103	7.0-7.2	365-384	134-138	6.25-8.52
	SC	c,d,e,f	c	e,f,g,h	c,d	c,d,e	i	c,d,e,f,g	e,f,g
Kinley	Mean±SD	608.33±104.26	55.17±7.88	663.50±101.37	107.33±0.58	7.1±0.1	578.66±12.22	212.66±5.77	8.14±1.18
	Range	520.0-723.3	47.83-63.50	583.5-777.5	107-108	6.8-7.1	568-592	206-216	6.82-9.08
	SC	a,b,c,d	c	c,d,e,f,g	a,b	c,d,e	d,e	a,b	e,f,g
Novel	Mean±SD	407.22±115.14	53.33±5.00	460.56±119.61	95.00±1.00	6.9±0.17	334.33±8.38	114.00±2.00	3.78±0+0.32
	Range	346.6-540.0	48.33-58.53	383.33-598.40	94-96	6.8-7.1	329-344	112-116	3.40-3.97
	SC	c,d,e,f	c	e,f,g,h	f,g	e,f	j	c,d,e,f,g,h	g
Natural	Mean±SD	745.56±69.01	105.72±17.26	851.28±61.64	94±1	7.4±0.1	520.66±4.04	155.33±37.54	13.225±0+1.63
	Range	671.7-808.3	87.00-109.16	780.82-895.30	93-95	7.37.5	516-523	112-178	11.36-14.2
	SC	a,b	c	c,d	g	b,c	f	c,d,e	c,d
Jel	Mean±SD	596.67±56.20	106.67±13.33	703.33±65.85	109.33±1.15	6.83±0.11	308.33±2.88	85.33±3.05	5.11±0+0.56
	Range	535.0-645.0	93.33120.0	628.33-751.70	108-110	6.7-6.9	305-310	82-88	4.54-5.68
	SC	a,b,c,d	c	c,d,e,f	a	e,f	k	g,h,i	f,g
Al -habib	Mean±SD	231.67±58.40	20.28±3.79	251.94±59.34	104.33+0.58	7.36±0.05	466.66±1.15	109.33±6.11	14.01±0+1.82
	Range	175-291.7	17.16-24.50	192.16-310.83	104-105	7.3-7.4	466-468	108-116	11.92-15.33
	SC	e,f	c	h	b,c	b,c	g,h	d,e,f,g,h,i	b,c,d
Sprinkle	Mean±SD	220.00±28.43	122.28±19.75	342.28±17.67	95.67±0.58	7.26±0.05	457.66±6.80	104.00±4.00	8.14±0.65
	Range	188.3-243.4	104.17-143.33	331.67-362.85	95-96	7.3-7.4	450-463	100-108	7.38-8.52
	SC	e,f	c	e,f,g,h	f,g	b,c,d	h	e,f,g,h,i	e,f,g
Iqra finu	Mean±SD	259.44±12.94	45.56±15.12	305.00±15.28	103.33±.53	6.66±0.05	183.33+±0.57	57.33±4.61	4.92±0.32
	Range	245.0-270.0	28.23-56.76	291.63-321.58	102-105	6.6-6.7	183-184	52-60	4.54-5.11
	SC	e,f	c	g,h	c,d	f	m	i	)f,g
Vey	Mean±SD	529.44±253.56	23.89±5.36	553.33±253.68	100.67±1.53	6.96±0.11	317.33±0.57	118.66±2.31	6.43±0.32
	Range	255.0755.0	20.0-30.1	276.5-775.0	99-102	6.9-7.1	317-318	116-120	6.24-6.82
	SC	b,c,d,e	c	d,e,f,g,h	d,e	d,e,f	j,k	c,d,e,f,g	f,g
Spring fresh	Mean±SD	433.89±71.77	23.33±3.33	73.34±73.34	95.67±1.15	7.6±0.26	473.33±0.57	149.33±2.31	9.46±4.26
	Range	360.0-503.5	20.0-26.70	383.23-530.0	95-97	7.4-7.9	473-474	148-152	4.54-11.92
	SC	b,c,d,e,f	c	e,f,g,h	f,g	b	g,h	c,d,e	d,e,f
Culligan	Mean±SD	330.56±73.04	61.11±20.84	391.67±52.92	101.33±0.58	6.86±0.05	303±13.89	86.66±2.31	3.97±0.56
	Range	270.0-411.6	40.0-61.7	351.7-451.92	101-102	6.8-6.9	294-364	84-88	3.40-4.56
	SC	d,e,f	c	e,f,g,h	c,d	e,f	k	g,h,i	g
Oas	Mean±SD	299.44±6.94	27.22±6.94	326.67±0.00	97.33±0.58	6.9±1.09e-15	363±2.64	122.66±6.11	7.19±1.82
	Range	291.8-301.6	21.5-40.0	326.67	97-98	6.9-6.9	360-365	116-128	5.11-8.52
	SC	d,e,f	c	f,g,h	e,f,g	e,f	i	c,d,e,f,g	f,g
Orian	Mean±SD	186.67±23.09	85.56±5.85	272.22±18.58	104.67±1.53	7.06±0.05	313.66±12.34	90.66±2.31	4.73±0.32
	Range	173.3-214.5	80.0-91.67	258.34-293.45	103-106	7.0-7.1	300-324	88-92	4.54-5.11
	SC	f	c	h	b,c	c,d,e	j,k	f,g,h,i	f,g
Sunlay	Mean±SD	258.33±47.64	120.00±40.03	378.33±22.05	97.33±0.58	7.16±0.11	678.33±2.30	132.00±0.00	18.36±1.31
	Range	205.0-296.6	88.33-165.0	361.0-403.35	97-98	7.1-7.3	677-681	132-132	17.60-19.88
	SC	e,f	c	e,f,g,h	e,f,g	c,d,e	c	c,d,e	b
Mountain	Mean±SD	648.33±271.44	75.56±65.88	723.89±330.82	95.33±2.52	7.96±0.05	817±6.55	202.66±6.11	12.49±0.56
	Range	345.0-868.2	20.0-148.43	365.0-1016.55	93-95	7.9-8.0	810-823	196-208	11.91-13.06
	SC	a,b,c	c	c,d,e	f,g	a	b	b,c	c,d,e
	F-value	13.79	64.25	22.05	51.90	25.82	5962.82	18.23	46.57
	P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

S. No.	Values	Alkalinity (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Sulphate (mg/L)	Sodium (mg/L)	AMC limit (cfu/mL)	Coliform limit (cfu/mL)	*E. coli* (cfu/mL)
PSQCA[1]			250	10	100	30	< 100 at 22°C (72 h)	0	0
WHO[2]			250	50	250	200			
EU[3]			-	-	250	150			
M1	Mean±SD	105.33±2.30	48.0±1.08	0.77±0.23	100.69±5.46	49.76±0.84	300±3.46	ND	ND
	Range	104-108	46.86-48.99	0.519-0.968	94.83-105.64	49.27-50.73	296-302	ND	ND
	SC	a,b	a	c	b,c,d	b	a,b	ND	ND

M2	Mean±SD	128±4.00	63.66±1.63	1.21±.003	116.94±1.86	48.15±1.10	235±72.52	ND	ND
	Range	124-128	61.77-64.61	1.183-1.236	114.84-118.39	47.25-49.38	158-302	ND	ND
	SC	a,b	a	c	b,c,d	b,c	b	ND	ND
M3	Mean±SD	314.66±12.22	214.18±1.78	36.54±1.49	198.92±1.53	54.73±0.49	320±37.75	13.33±2.08	4.0±1.0
	Range	304-328	212.2-215..8	34.85-37.70	197.42-200.48	54.26-55.24	280-355	11.0-15.0	3.0-4.0
	SC	a,b	a	a	a	a	a	ND	ND
M4	Mean±SD	124±0.00	71.23±1.47	1.03±0.13	123.82±1.07	48.57±0.62	274±25.36	ND	ND
	Range	124-125	69.58-72.42	0.896-1.146	122.90-125.00	49.27-48.36	245-292	ND	ND
	SC	a,b	a	c	b,c	b,c	a,b	ND	ND
Aquafina	Mean±SD	56±6.92	30.05±.040	0.257±0.037	76.56±6.48	21.53±0.22	8.00±2.00	ND	ND
	Range	52-54	29.82-30.53	0.215-0.286	70.48-83.38	21.35-21.78	6.00-10.00	ND	ND
	SC	b	a	c	c,d,e,f	i,j	f	ND	ND
Nestle	Mean±SD	57.33±2.30	81.65±1.42	0.209±0.179	25.97±1.54	16.92±0.39	14.00±4.00	ND	ND
	Range	56-60	80.23-83.07	0.197-0.394	24.19-26.93	16.51-17.28	10.00-18.00	ND	ND
	SC	b	a	c	f,g,h	k	f	ND	ND
Kinley	Mean±SD	118.66±18.47	127.56±2.28	0.269±0.036	49.57±2.57	21.79±0.68	25.33±4.51	ND	ND
	Range	108-140	124.9-129.2	0.233-0.305	46.61-51.29	21.20-22.54	21.00-30.00	ND	ND
	SC	a,b	a	c	e,f,g,h	i,j	f	ND	ND
Novel	Mean±SD	60±10.58	73.84±0.71	0.179±0.182	79.52±66.35	31.29±1.35	41.67±3.78	ND	ND
	Range	48-68	73.13-74.55	0.017-0.376	41.12-156.13	30.16-32.76	39.00-46.00	ND	ND
	SC	b	a	c	c,d,e	e,f	e,f	ND	ND
Natural	Mean±SD	134.66±38.85	86.85±15.59	15.33±10.23	106.61±17.48	17.99±1.31	165.33±27.74	ND	ND
	Range	92-168	68.87-96.56	3.530-21.50	90.00-124.84	16.97-19.47	142-196	ND	ND
	SC	a	a	b	b,c,d	j,k	c	ND	ND
Jel	Mean±SD	46.66±4.61	66.50±1.08	5.722±0.787	19.03±0.43	45.73±0.59	119±4.58	ND	ND
	Range	44-52	65.3267.54	4.820-6.272	18.70-19.52	45.09-46.26	114-123	ND	ND
	SC	b	a	c	g,h	c,d	c,d	ND	ND
Al -habib	Mean±SD	148±4.00	56.56±0.40	13.14±0.176	77.42±1.71	45.85±0.95	256±10.58	ND	ND
	Range	144-152	56.09-56.80	12.93-13.27	76.13-79.35	45.09-46.92	248-268	ND	ND
	SC	a,b	a	b	c,d,e	c,d	a,b	ND	ND
Sprinkle	Mean±SD	105.33±6.11	58.45±2.49	13.73±0.177	66.45±3.41	50.06±1.39	44±4.58	ND	ND
	Range	100-104	56.09-61-06	13.53-13.85	63.87-70.32	49.23-51.67	39-48	ND	ND
	SC	a,b	a	b	d,e,f,g	b	e,f	ND	ND
Iqra finu	Mean±SD	113.33±2.30	41.65±0.81	2.658±0.132	6.02±1.31	27.06±0.97	124.37±11.02	ND	ND
	Range	112-116	41.18-42.60	2.50-2.75	4.52-6.94	26.13-28.06	113-135	ND	ND
	SC	a,b	a	c	h	g,h	c,d	ND	ND
Vey	Mean±SD	45.33±2.30	69.10±0.40	0.854±0.502	39.41±0.98	23.57±1.24	43.67±5.13	ND	ND
	Range	44-48	68.87-69.58	0.3401.344	38.55-40.48	22.24-24.69	38-48	ND	ND
	SC	b	a	c	e,f,g,h	h,i	e,f	ND	ND
Spring fresh	Mean±SD	46.66±2.30	49.46±0.40	13.01±0.434	77.85±0.79	49.98±1.22	241.72±9.07	ND	ND
	Range	44-48	48.99-49.70	12.74-13.51	76.94-78.39	49.28-51.38	232-250	ND	ND
	SC	b	a	b	c,d,e	b	b	ND	ND
Culligan	Mean±SD	124±4.00	74.07±0.40	1.881±0.124	b.d	30.12±2.16	12.34±2.52	ND	ND
	Range	120-128	73.84-74.55	1.810-2.025	-	28.22-32.46	10-15	ND	ND
	SC	a,b	a	c	h	f,g	f	ND	ND
Oas	Mean±SD	54.66±2.30	89.93±1.08	0.693±0.464	20.05±1.05	34.06±0.63	167.45±21.94	ND	ND
	Range	52--56	88.75-90.88	0.340-1.218	19.03-21.13	33.69-34.78	143-185	ND	ND
	SC	b	a	c	g,h	e	c	ND	ND
Orian	Mean±SD	40.0±4.00	62.24±1.47	0.304±0.129	40.22±3.50	43.62±0.81	93.66±5.13	ND	ND
	Range	36-44	61.06-63.90	0.197-0.448	36.45-43.38	43.15-44.56	88-98	ND	ND
	SC	b	a	c	e,f,g,h	d	d,e	ND	ND
Sunlay	Mean±SD	66.66±6.11	94.43±1.87	15.39±0.542	126.08±3.55	51.07±1.68	21±3.60	ND	ND
	Range	60-72	93.01-96.56	14.98-16.00	122.42-129.51	49.27-52.59	18-25	ND	ND
	SC	b	a	b	b,c	a,b	f	ND	ND
Mountain	Mean±SD	101.33±2.30	104.37±0.71	1.016±0.102	144.03±24.72	51.94±3.04	67±10.15	ND	ND
	Range	100-104	103.7-105.1	0.932-1.129	127.26-172.42	49.27-55.25	58-78	ND	ND
	SC	b	a	c	b	a,b	d,e,f	ND	ND
	F-value	2.65	1.600	47.71	29.39	326.0		ND	ND
	P-value	0.005	0.104	0.000	0.000	0.000		ND	ND

[a]Data are expressed as mean±standard deviation (n = 3); values within each type of physiochemical property marked by the same letter within same column are not significantly different (P < 0.05), [1]Pakistan standards specifications for bottled drinking water (PSQCA 2004-Pakistan Standards PS: 4639-2004 (r), [2]World Health Organization (WHO) guidelines for drinking water (WHO 1993), [3]Ikem *et al*. 2002.

Electrical conductivity showing significant positive correlation with all physiochemical parameters acidity (r = 0.787) > Cl^- (r = 0.875) > SO_4^{2-} (r = 0.827) > alkalinity (r = 0.808) > hardness (r = 0.790) > NO_3^- (r = 0.751) > Na (r = 0.532). It is previously reported that electrical conductivity having strong correlation with physiochemical parameters [9], little disagreement were only in case of Na as negative correlation were reported. Electrical conductivity showing insignificant negative correlation with sensory attributes applied majorly after taste (r = -0.350) > mineral quantity (r = -0.275) > odor (r = -0.186) > carbonation (r = -0.138) > overall likeness (r = -0.137). Averagely electrical conductivity values of municipal samples are twofold higher than commercial samples.

Hardness: Hardness having significant impact on sensorial acceptability of water as well as it is a major driving factor of customer's perception and preference for bottled drinking water, positive health impacts are also reported [5,11,13]. PSQCA set the standard of 250 mg/L, in studied samples no one in municipal (average; 190.33, 144-228 mg/L) and commercial (average; 119.39, 57.33-212.67 mg/L) samples exceeded the limit, all found in narrow range with notable significance difference. Municipal samples (M3 and M4) having significantly high values among others, this might be due to obtaining water by bore well or mix-up of rock sludge as ground resources have higher amount of calcium and magnesium that can enter the water source through the weathering of rocks [9,14].

Hardness indicated significant strong positive correlation with Cl^- (r = 0.746) > SO_4^{2-} (r = 0.691) > acidity (r = 0.667) > alkalinity (r = 0.548). Our findings supported by previous studies of Gupta *et al*. [13], Bhandari and Nayal [9] that hardness is positively correlated with Cl^-, SO_4^{2-} and alkalinity. A little disagreement was also presented with Bhandari and Nayal [9] (reported negative correlation of hardness with Na and electrical conductivity). On sensorial properties hardness negatively correlated with carbonation (r = -0.53) > odor (r = -0.225) > mineral quantity (r = -0.190) > after taste (r = -0.186) > overall likeness (r = -0.152). Kempster *et al*. [11] and Lou *et al*. [5] are in well agreement with our findings, they reported that hardness can significantly effects the taste and acceptability of drinking water as higher hardness leads to bad after metallic taste but if it is in controlled range then will impact positively on acceptability.

Acidity and alkalinity: Acidy and alkalinity by pH is an important parameter for defining the water quality index. If something happens to water both pH and TDS will change or we can say that they act as an early warning signals. Total dissolved solids and pH levels monitoring is requisite frequently, if these values change then action can be taken immediately [15]. When total hardness is the total alkalinity called non-carbonate hardness and indicates the presence of chloride and sulfate ions which is the case in this study [16]. In present samples for acidity we recorded those commercial samples (average; 8.88, 3.79-18.36 mg/L) which have significantly low values than municipal (average 19.5, 9.65-29.35 mg/L) samples. The same behaviour is observed in case of alkalinity that municipal (average; 214.66, 105.33-314.67 mg/L) samples having significant high values than commercial (average; 87.08, 40-148 mg/L). These might be due to rocks catchment in municipal samples [17].

Acidity correlated positively with SO_4^{2-} (r = 0.832) > NO_3^- (r = 0.762) > alkalinity (r = 0.758) > Cl^- (r = 0.666) > AMC (r = 0.618) > Na (r = 0.594) and negatively with after taste (r = -0.363) > mineral quantity (r = -0.360) > sound (r = -0.181) > Carb (r = -0.145) > Ap (r = -0.142) > Od (r = -0.117) > Ov (r = -0.105). This output indicates that water having anions of SO_4^{2-}, NO_3^- and Cl^- with alkaline compounds. Acidity is negatively impacted on sensorial acceptability. Same like acidity; alkalinity positively correlate with Cl^- (r = 709) > NO_3^- (r = 705) > SO_4^{2-} (r = 603) > AMC (r = 562) and negatively correlation with all sensorial parameters *i.e*. after taste (r = -0.502) > sound (r = -0.356) > appearance (r = -0.335) > mineral quantity (r = -0.298) > odor (r = -0.295) > overall likeness (r = -0.234) > carbonation (r = -0.152). Our findings supported by Vikal [10] (reported positive correlation of alkalinity with hardness). Alkalinity showing negative correlations with all sensorial attributes as alkalinity leads to bitter taste and bad after metallic tastes. Lou *et al.* [5] also reported that alkalinity having impacts on acceptability.

Chloride: Chloride is an important parameter to find out pollution contamination as unpolluted water having chloride concentration in range of 1-10 mg/L [18,19]. At concentration below 200 mg/L chloride does not show any adverse health effect, it may be injurious to some people suffering from diseases of the heart or kidneys. Restrictions on chloride concentrations in drinking water are generally based on taste requirements rather than on health (Kempster *et al*. [11], WHO [18,20]. EU and PSQCA [16] set-up 250 mg/L threshold value for chloride. In our studied samples none of municipal (average; 136.91, 48.04-214.18 mg/L) samples and commercial (average; 75.79, 30.06-127.56 mg/L) violated the limit. No significance difference was observed in both types of samples. Chloride positively correlated with NO_3^- (r = 0.616) and SO_4^{2-} (r = 0.528) whilst showing negative correlation with after taste (r = -0.352) > overall likeness (r = -0.287) > odor (r = -0.215) > carbonation (r = -0.146) > mineral quantity (r = -0.141) > appearance (r = -0.135) > sound (r = -0.060). It indicates that water containing chloride, nitrate and sulphate ions salts. Our findings supported by Gupta *et al.* [13]; Vikal [10]; Bhandari and Nayal [9] (reported Cl possess strong correlations with hardness, SO_4^{2-} and NO_3^-). Chloride ions correlates negatively with all examined sensorial attributes because it leads to salty taste that can be disliked by consumer as reported by Kempster *et al.* [11] that chloride in water with above 200 mg/L can leads to salty taste and will not slake thirst.

Nitrate: Nitrate in water is a serious health concern, in the concentration range of 10-20 mg/L (as N) of nitrate plus nitrite, there is a definite possibility of methaemoglobinaemia in bottled fed infants, while above 20 mg/L the water is definitely unfit for use by infants. Nitrate groundwater contamination can never be rectified [11,19]. To minimize health risk MCL for nitrate is 50 mg/L set up by WHO while in Pakistan which is having high ratio of infant death PSQCA set up 10 mg/L. Notable significance difference were observed among samples. In municipal samples M3 violently exceeded the limit (36.54 mg/L) while M1, M2 and M4 having values of 0.77, 1.21, 10.3 mg/L respectively. All commercial samples were found in a range of 0.18-15.39 mg/L (averagely 6.233 mg/L), no one exceeded from WHO standards but 31.25 % samples (Natural, Al Habib, Sprinkel, Spring fresh, Sunlay) exceeded by the limit of 10 mg/L set up by PSQCA [14], it is to be noted that the samples who exceeded the limit are un popular products. NO_3^- shares positive correlation with SO_4^{2-} (r = 0.578), Na (r = 0.484) and AMC (r = 0.450) and positively correlated with the overall likeness (r = 0.212). Strong negative correlation were found with appearance (r = -0.145) and after taste (r = -0.121). Our findings are in disagreement with Bhandari and Nayal [9] (reported negative correlation with sodium). Nitrate correlate negatively specially with appearance and in taste.

Sulphate: Sulphates occur naturally in groundwater as calcium, magnesium and sodium salts. Sulfate content in excess of 250 to 500 mg/L may give water a bitter taste and have a laxative effect on individuals [5]. Elevated concentrations commonly originate in areas where pyrite deposits are found which have been distributed by different human activities [11]. In our studied samples none of commercial and municipal samples violated the limit of EU and WHO while all municipal samples violated the PSQCA limit of 100 mg/L (average;

155.58, 100.69-198.92 mg/L) this might be due to mix-up of rocks during distribution. Three commercial samples (Mountain, Sunlay, Natural) exceeded from the PSQCA limit (144.03, 126.08, 106.61 mg/L respectively) this might be due to careless production by applying cheap methods of filtration and desalination.

Sulfate ions shares positive correlation with Na (r = 0.621) and AMC (r = 0.511) and strong negative correlation with mineral quantity (r = -311), odor (r = -250) and after taste (r = -216) also having negligible positive correlation with overall likeness (r = 0.077). Sulphate correlated negatively specially with metallic taste, odor and after taste, this is supported by Kempster *et al.* [11] that higher sulphate concentration leads to bitter taste.

Sodium: Sodium in water is important due to sensory impacts prior to health concerns [12]. No adverse health effects are apparent at sodium concentrations of below 200 mg/L; a slight taste may be apparent above 100 mg/L; in concentration range 200-400 mg/L the effect is usually aesthetic (salty taste) above these limits it is associated with hypertension and urological problems [11]. Due to importance of sodium PSQCA set up limit 30 mg/L while WHO and EU 200 mg/L and 150 mg/L respectively. In our studied samples significance differences were observed and all found in a narrow range. None of municipal and commercial samples exceeded the EU and WHO limits while in comparison with PSQCA limits all municipal samples violated the limit with average of 51.54 mg/L (48.15-54.73 mg/L). Majorly commercial samples were also violated the limits (Novel, Jel, Al Habib, sprinkle, Spring fresh, Culligan, Oas, Orion, Sunlay, Mountain), all found to be in range of 16.92-51.94; averagely 37.89 mg/L. Stringent actions against this violation is requisite in studied population which is having high hypertension and urological problems ratio.

Sodium shows positive and significant correlation with AMC (r = 0.580) > after taste (r = 0.021) and overall likeness (r = 0.077). We get positive correlation of sodium with other physiochemical properties unlike Bhandari and Nayal [9] who have found negative correlation, Na posses very slight positive correlation especially with after taste and overall likeness. In our studied samples all were found in narrow range that's why it is showing positive correlation whilst salty taste on incremented concentrations has been reported by Kempster *et al.* [11].

Bacteriological analysis: According to PSQCA standards 100 % (average 311.75; 245-355 cfu/mL) of the examined municipal samples and 43.75 % (average 109.81; 10-268 cfu/mL) of commercial samples were bacteriologically unacceptable. Municipal samples significantly exceeded the tolerable limits over commercial samples. At above 10 counts per 100 mL there is an increasing risk of disease transmission [11]. Higher AMC limits in bottled water indicate the poor GMP in plants and in municipal samples it might be due to environmental airborne contamination [21]. The coincide result were given by El-Salam *et al.* [22]. Furthermore the fecal coliforms and *E. coli* were only detected in municipal sample M3 that has value of 13.33 cfu/mL for colliform and 4 cfu/mL for *E. coli* bacteria. Bacteria presence is a serious health concern and must be absent.

AMS shares positive correlation with coliforms and *E. coli* (r = 0.301; for both) whilst showing negative correlation with all (except odor) sensorial parameters *i.e.* mineral quantity (r = -0.256) > after taste (r = -0.173) > Ap (r = -0.135). Coliform showing significant positive correlation with *E. coli* (r = 1) and showing negative correlation with carbonation (r = -0.119) and odor (r = -0.032). On neglecting the after taste due to health concern *E. coli* showing negative correlation with carbonation (r = -0.119) and odor (r = -0.032). All the bacteriological properties are important by health point of view rather than taste [13]. According to our findings the bacterial contamination leads to negative correlation and lowers the overall acceptability especially by production of unpleasant offensive odor.

General summary of sensory analysis with correlations: Sensorial attributes of water strongly influenced by physiochemical composition of water, varied with different ratios at certain concentrations [6,13,15]. As shown in Table-2 in our studied samples there is no significance difference observed among samples. On average basis commercial samples get the notable positive markings by assessors. Our findings are strongly in agreement with other studies that consumers insignificantly feels the change in taste presented by Lou *et al.* [5], Falahee and MacRae [1], Teillet *et al.* [23] and Sipos [2]. Overall for odor commercial get 5.83 over municipal 5.38, for after taste commercial 5.69 over municipal 5.03, for carbonation commercial 4.81 over municipal 4.42, for appearance commercial 6.01 over municipal 5.74, for sound commercial 5.16 over municipal 4.96, for mineral quantity commercial 5.15 over municipal 4.71, for overall likeness commercial gets 5.44 over municipal 5.09, it was reported previously that difference in taste resulted by variation in physiochemical parameters is not clear [15].

Willing to pay behaviour and purchase intent factor motivation assessment: Behind every successful product there is solid connection between willing to pay (WTP) behaviour and purchase intent (PI) of customers *i.e.* decision factors and reasons to buy and prefer product. There are several influential factors reported, knowledge is a relevant and significant construct that affects how consumers accumulate and categorize information [24], how much information is utilized in choice making [25] and how consumers appraise products and services [23], eco-literacy, socio economic, demographic, ethics, organoleptics, health and risk aversion are major causes that drives the consumers willing to pay behaviour and makeup purchase intent for product willing to pay behaviour and purchase intent factor analysis expressed in Figs. 1 and 2, respectively. Consumer's response towards price increment is an inverse relationship with each other, consumers can bear only 10-30 % increment (on total population basis) for their favourite brand, previously reported data by Sipos [2] strongly support to our results. Sipos [2] reported 10 to 20 % increment bearable values but here we have find out a new fact that male consumers show more sensitivity towards price increment rather than females. Purchase intent analysis shows that independently by situation organoleptics and price of water is exceedingly important, brands have negligible effect at any situation, certificate have equal importance in all situations,

TABLE-2
SENSORY ATTRIBUTES OF TAP (FROM DIFFERENT LOCATIONS) AND BOTTLED (DIFFERENT BRANDS) WATER[a]

Sample ID	Values	Odor	After taste	Carbonation	Appearance	Sound	Mineral quantity	Overall likeness
M1	Mean±SD	5.6±2.32	5.0±2.44	4.68±3.09	5.72±2.62	4.8±1.68	4.52±2.31	4.96±2.49
	SC	a	a	a	a	a	a	a
M2	Mean±SD	4.92±1.95	4.6±2.25	3.76±2.12	6.16±1.97	5.16±2.73	4.24±1.64	4.6±2.27
	SC	a	a	a	a	a	a	a
M3	Mean±SD	5.44±2.34	4.68±2.42	4.84±1.62	5.64±1.75	4.76±1.92	4.76±1.92	5.08±2.19
	SC	a	a	a	a	a	a	a
M4	Mean±SD	5.56±2.10	5.84±2.11	4.4±2.06	5.44±2.8	5.12±2.04	5.32±2.37	5.72±2.09
	SC	a	a	a	a	a	a	a
Aquafina	Mean±SD	5.52±1.78	5.72±2.05	5.12±1.83	5.72±1.92	4.88±2.16	4.8±2.39	5.84±1.74
	SC	a	a	a	a	a	a	a
Nestle	Mean±SD	5.76±2.42	5.56±2.38	4.16±2.11	6.56±1.91	5.24±2.33	5.28±2.20	4.84±2.88
	SC	a	a	a	a	a	a	a
Kinley	Mean±SD	4.96±1.88	4.8±1.77	4.44±2.00	5.36±1.82	5.28±2.30	4.52±2.12	4.92±2.08
	SC	a	a	a	a	a	a	a
Novel	Mean±SD	5.0±2.29	5.32±1.886	5.12±1.69	6.28±1.56	5.28±1.42	5.24±1.50	5.48±1.82
	SC	a	a	a	a	a	a	a
Natural	Mean±SD	5.8±1.97	6.28±1.81	4.68±2.17	6.2±1.91	5.24±2.04	5.4±1.97	5.56±1.66
	SC	a	a	a	a	a	a	a
Jel	Mean±SD	5.72±1.81	5.08±2.23	4.12±1.96	6.16±1.92	5.08±2.39	4.88±2.14	5.0±1.95
	SC	a	a	a	a	a	a	a
Al-habib	Mean±SD	5.64±1.70	5.24±1.83	4.84±1.57	5.96±1.59	5.0±2.25	4.92±2.05	5.88±1.53
	SC	a	a	a	a	a	a	a
Sprinkle	Mean±SD	5.2±1.97	5.6±1.97	5.0±2.04	5.76±1.92	5.56±1.63	5.16±1.65	5.52±1.89
	SC	a	a	a	a	a	a	a
Iqra finu	Mean±SD	6.71±1.70	5.71±2.56	5.28±2.81	5.57±2.22	4.0±2.51	5.14±2.54	5.14±1.86
	SC	a	a	a	a	a	a	a
Vey	Mean±SD	6.04±2.42	6.4±2.38	5.08±2.32	6.6±2.17	5.68±2.07	6.56±2.21	5.84±2.07
	SC	a	a	a	a	a	a	a
Spring fresh	Mean±SD	6.84±1.77	6.6±1.73	5.2±2.12	6.44±1.52	5.88±1.96	5.28±2.30	6.36±1.77
	SC	a	a	a	a	a	a	a
Culligan	Mean±SD	5.76±2.25	5.4±2.08	4.36±2.25	5.8±2.32	5.16±1.95	5.28±2.47	5.2±2.25
	SC	a	a	a	a	a	a	a
Oas	Mean±SD	6.32±2.05	6.12±2.00	5.08±2.51	5.88±2.20	5.48±2.16	5.16±2.42	5.32±2.54
	SC	a	a	a	a	a	a	a
Orian	Mean±SD	5.84±1.92	5.68±2.03	5.04±2.3	5.72±2.11	5.04±2.35	4.96±2.37	5.16±2.11
	SC	a	a	a	a	a	a	a
Sunlay	Mean±SD	6.2±1.95	5.68±1.72	4.92±1.84	5.56±2.10	5.04±1.61	4.88±1.92	5.75±2.06
	SC	a	a	a	a	a	a	a
Mountain	Mean±SD	6.04±2.38	5.84±2.70	4.44±2.46	6.64±2.34	4.72±2.15	4.96±2.87	5.16±2.30
	SC	a	a	a	a	a	a	a
Overall								
	Municipal	5.38+0.31a	5.03+0.56a	4.42+0.47a	5.74+0.30a	4.96+0.20a	4.71+0.45a	5.09+0.46a
	Commercial	5.83+053a	5.68+0.48a	4.80+0.38a	6.01+0.40a	5.16+0.43a	5.15+0.44a	5.43+0.41a
F-value		0.19	0.20	0.11	0.11	0.11	0.14	0.13
P-value		1.00	1.00	1.00	1.00	1.00	1.00	1.00

[a]Data are expressed as mean±standard deviation (n = 3 populations; total, male and female); values within each type of sensory attribute marked by the same letter within same column are not significantly different ($p < 0.05$).

award, prize winning, packaging, minerals, advertisements, availability can be persuasive for waters for routine use, friends recommendations are more important than family members, by this it is concluded that purchasing decisions can strongly be driven by situations like recommendations, education, health consciousness and mass media (Fig. 2), these findings are in strongly agreement with Doria [3] that consumer behaviours are situation dependent.

Consumer satisfaction towards preference and perception by blind assessment: The results of our survey revealed that usage of municipal water supply for drinking purpose is significantly higher (64.38 %) than other two classes *i.e.* bottled (25.36 %) and well (10.25 %), the regular users of bottled water are found to be significantly low (20.32 %) majorly bottled water used on occasionally (67.80 %) but interestingly about 54.13 % respondents prefer bottled water to drink and main reason behind this is they significantly (49.10 %) suggest it to be safe and significantly (62.76 %) prefer bottled water due to health concerns rather than taste (21.94 %) and economical (11.87 %) factors. Among 25 respondents 67.80 % declare them to be health conscious but they neglect the contribution of mass media (20.32 %) to make up their choice to prefer bottled water by thinking about it to be safe. They give significantly high markings about contribution to literature (40.64 %) and own sensorial senses (39.02 %), they attracted toward product and prefer by taste (59.35 %) and sight (47.30 %), about 54.31 % respondents are confident that they can identify their preferred brand of water which they use in their daily life, about 71.22 % respondents did not trust local water distribution system at their vicinity, only 6.83 % respondents were found to be satisfied with their local tap water majorly 53.96 % mark it as acceptable and about 3.41 % are totally

TABLE-3
CORRELATION COEFFICIENTS OF PHYSIOCHEMICAL WITH SENSORY ATTRIBUTES[x]

Correlation	TDS	TSS	TS	BP	pH	EC	Hrd	Acd	Alk	Cl^-	NO_3^-	SO_4^{2-}	Na	AMC	Colliforms	*E. coli*	OD	AT	CARB	AP	SO	MQ	OV
TDS	1	.196	.762**	-.171	.508*	.595**	.631**	.357	.479*	.635**	.349	.478*	.101	.317	.523	.523	-.116	.007	-.271	.086	.030	.175	-.014
TSS	.196	1	.762**	.245	-.052	.453	.373	.588**	.487*	.192	.156	.570**	.520*	.662**	.309	.309	-.398	-.535*	-.442	-.260	-.204	-.472*	-.410
TS	.762**	.762**	1	.034	.290	.723	.677	.664**	.659**	.595**	.383	.690**	.394	.619**	.564*	.564*	-.341	-.387	-.462*	-.057	-.119	-.226	-.330
BP	-.171	.245	.034	1	-.538*	-.270	-.255	-.173	-.082	-.214	-.373	-.367	-.128	.074	-.349	-.349	-.212	-.532*	-.404	-.321	-.300	-.356	-.464*
pH	.508*	-.052	.290	-.538*	1	.598**	.635**	.440	.329	.413	.461*	.625**	.464*	.236	.208	.208	.100	.251	-.033	.271	.170	.045	.333
EC	.595**	.453*	.723**	-.270	.598**	1	.790	.887**	.808**	.875**	.751**	.827**	.532*	.481*	.142	.142	-.186	-.350	-.138	-.127	-.133	-.275	-.137
Hrd	.631**	.373	.677**	-.255	.635**	.790**	1	.667**	.548*	.746**	.368	.691**	.289	.366	.205	.205	-.225	-.186	-.253	.028	.123	-.190	-.152
Acd	.357	.588**	.664**	-.173	.440	.887**	.667	1	.758**	.666**	.762**	.832**	.594**	.618**	.304	.304	-.117	-.363	-.145	-.142	-.181	-.360	-.105
Alk	.479*	.487*	.659**	-.082	.329	.808**	.548	.758**	1	.709**	.705**	.603**	.332	.562**	.366	.366	-.295	-.502*	-.152	-.335	-.356	-.298	-.234
Cl^-	.635**	.192	.595**	-.214	.413	.875**	.746	.666**	.709**	1	.616**	.528*	.191	.214	.142	.142	-.215	-.352	-.146	-.135	-.060	-.141	-.287
NO_3^-	.349	.156	.383	-.373	.461*	.751**	.368	.762**	.705**	.616**	1	.578**	.484*	.450*	.415	.415	.044	-.121	.186	-.145	-.017	-.085	.212
SO_4^{2-}	.478*	.570**	.690**	-.367	.625**	.827**	.691	.832**	.603**	.528*	.578**	1	.621**	.511*	.298	.298	-.250	-.216	-.092	-.054	-.130	-.311	.077
Na	.101	.520*	.394	-.128	.464*	.532*	.289	.594**	.332	.191	.484*	.621**	1	.580**	-.187	-.187	.021	-.180	-.085	-.107	-.042	-.362	.077
AMC	.317	.662**	.619**	.074	.236	.481*	.366	.618**	.562**	.214	.450*	.511*	.580**	1	.301	.301	.040	-.173	-.078	-.135	-.108	-.256	.025
Colliforms	.523	.309	.564*	-.349	.208	.142	.205	.304	.366	.142	.415	.298	-.187	.301	1	1.00**	-.032	.324	-.119	.147	.042	.146	.079
E. coli	.523	.309	.564*	-.349	.208	.142	.205	.304	.366	.142	.415	.298	-.187	.301	1.000**	1	-.032	.324	-.119	.147	.042	.146	.079
OD	-.116	-.398	-.341	-.212	.100	-.186	-.225	-.117	-.295	-.215	.044	-.250	.021	.040	-.032	-.032	1	.704**	.455*	.193	-.081	.394	.417
AT	.007	-.535*	-.387	-.532*	.251	-.350	-.186	-.363	-.502*	-.352	-.121	-.216	-.180	-.173	.324	.324	.704**	1	.516*	.373	.374	.728**	.696**
CARB	-.271	-.442	-.462*	-.404	-.033	-.138	-.253	-.145	-.152	-.146	.186	-.092	-.085	-.078	-.119	-.119	.455*	.516*	1	-.143	.013	.374	.630**
AP	.086	-.260	-.057	-.321	.271	-.127	.028	-.142	-.335	-.135	-.145	-.054	-.107	-.135	.147	.147	.193	.373	-.143	1	.372	.439	.098
SO	.030	-.204	-.119	-.300	.170	-.133	.123	-.181	-.356	-.060	-.017	-.130	-.042	-.108	.042	.042	-.081	.374	.013	.372	1	.398	.401
MQ	.175	-.472*	-.226	-.356	.045	-.275	-.190	-.360	-.298	-.141	-.085	-.311	-.362	-.256	.146	.146	.394	.728**	.374	.439	.398	1	.504*
OV	-.014	-.410	-.330	-.464*	.333	-.137	-.152	-.105	-.234	-.287	.212	.077	.077	.025	.079	.079	.417	.696**	.630**	.098	.401	.504*	1

*Correlation is significant at 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).
BP = Boiling point, EC = Electrical conductivity, Hrd = Hardness, Acd = Acidity, Alk = Alkalinity, AMC =
OD = Odor, AT = After taste, CARB = Carbonation, AP = Appearance, SO = Sound, MQ = Mineral quantity, OV = Overall likeness

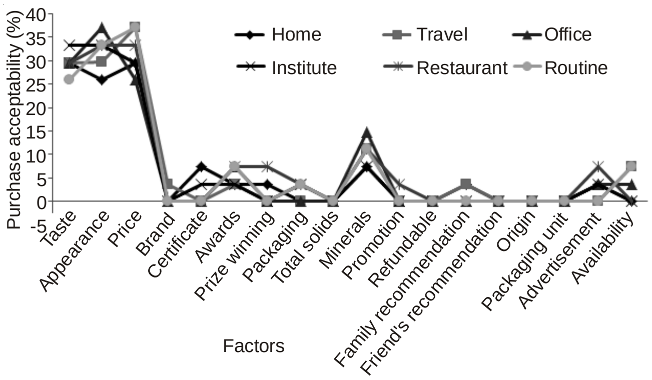

Fig. 1. Consumer behaviour towards price increment; WTP - Test (% hit rate)[a] [[a]Data expressed as mean ± standard deviation (n = 3 populations; total, male and female; % hit rate)]

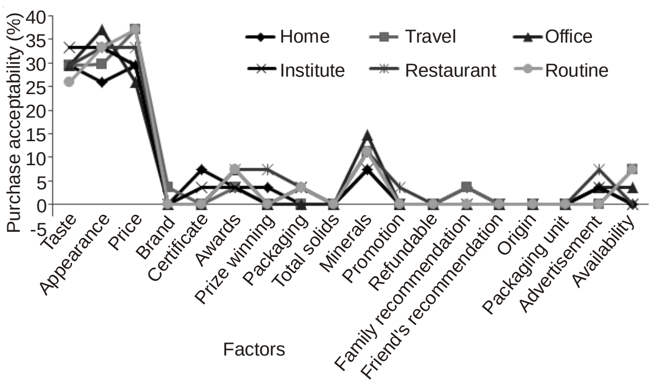

Fig. 2. Decision factor for purchasing mineral water (% hit rate)[a]; [[a]Data expressed as mean (n = 3 populations; total, male and female; % hit rate)]

TABLE-4
DEMOGRAPHIC VARIABLES OF RESPONDENTS

Demographic characteristics of sensory panel	
Gender	
Male	09 (36 %)
Female	16 (64 %)
Age	
21-30	25 (100 %)
Education level	
Graduate	05 (20 %)
Master	18 (72 %)
Doctoral	02 (8 %)
Residential area	
South	02 (8 %)
East	04 (16 %)
Central	05 (20 %)
West	07 (28 %)
Malir	07 (28 %)
Occupation	
Student	22 (88 %)
Teacher	2 (8 %)
Other	1 (4 %)
Physical status	
Flu	5 (20 %)
Fever	1 (4 %)
Feel thirsty	9 (36 %)
Betel nut chewer	1 (4 %)
Total population	25 (100 %)

dissatisfied the main reasons behind these are health concern (39.02 %), water resources are inappropriate (20.30 %) and unpleasant mouth feel (8.45 %). In our survey Nestle (45.86 %), Aquafina (25.36 %), Oslo (11.87 %), Kinlay (8.45 %) and Culligan (8.45 %) found to be top most favourite brands among population [7,26,27]. On comparison with previous reported literature (Table-4) this survey based study indicates that besides the demographic variables health concern and majorly organoleptics are the top most factors for consumers to switch to alternatives of local water *i.e.* bottled water while mineralization, convenience and trend has low values [5]. Here we found new factor that where consumers think their water resources are in appropriate, consumers significantly preferred and switch to bottled water due to health concerns rather than organoleptics. Furthermore the economical factor has been found to be effective.

On blind test to like a sample respondents significantly mark up the property of no unpleasant flavours (35.20 %) over sweet (24 %) and another unspecified reasons (19.40 %), whilst the most dissatisfaction reasons found are no special feelings (24.6 %), metallic taste (17.6 %), tickle the throat (13.8 %), astringent (11.8 %), sweet (11.2 %), bitter (14.8 %), salty

(9.4 %) and other unspecified reasons (10.6 %), the coincide results reported by Lou *et al.* [5] that respondents majorly like a sample due to no unpleasant feelings, in case of dislike the sample of our study partially supports Lou *et al*. [5]. We have found factors in an order: no special feelings > metallic taste > sweet > tickle the throat > bitter > astringent > salty > others, interestingly some consumers dislike the sample for having sweetness this indicates to like or dislike a sample is a matter of personal choice. On average basis 50 % respondents correctly identify the local water and 49 % respondents correctly identify their favourite brands among samples while on overall basis by neglecting the favourite brand criteria, 55.60 % respondents correctly identify the commercial samples (data not shown), that indicates that consumers are able to identify the type by their sensorial ability, on mineralization ability respondents have given excellent correct predictions on local samples while in case of commercial samples according to their responses they act to be confused that might be due to testing of too much samples at a same time that indicates that respondents can easily identify among low population while in a case of high population they can get confused of these findings supported by Sipos [2] that the total trend of the waters is in accordance with the expectation. Respondents were also asked to pick up one sample of their favourite brand, interestingly and significantly they picked wrong sample as their favourite brand (76.10 %) while in a survey 54.31 % respondents were confident that they identified their preferred brand; our findings are in line with previously reported literature of Sipos [2] that consumers are usually not able to identify their favourite, frequently consumed waters in a blind test, but we found a new factor that consumers are able to distinguish between type rather than brand. Another interesting fact found in a blind test that respondents were asked to markup their most liked and disliked samples, in most liked samples three bottled (Kinlay, Vey, Aquafina) and two local M1 and M3 were chosen majorly, interestingly male chose the local water samples and female showing likeness to commercial samples, it is to be noted that M1 and M3 having similar physiochemical properties like commercial samples, on other hand the top most disliked samples are majorly unpopular brands *i.e*. Iqrafinu, Oas, Mountain, Sprinkel, Jel and two local samples M2 and M4; an interesting factor is also observed here that male respondents dislike the local samples and only one commercial sample of Mountain while female respondents showing dislikeness to commercial samples, this indicates that male respondents frequently used local water and females frequently used commercial water, previously no data were reported in this regards.

Conclusion

The major reason of this study was to investigate possible correlations among physiochemical characteristics and sensorial attributes with aiming to define consumer's preference and perception in association with willing to pay behaviour and decision making psycho-logic scenario. First of all it is concluded that sensorial acceptability is strongly influenced and correlated by physiochemical characteristics of water, in spite of demographic variables consumers dislike excess and/ or squat presence of chemical species in their drinking water, they are able to characterize or to judge the quality by their own sensorial abilities. The second main finding is that health concern is major driving factor to switch to alternative of local tap water which belongs to low income per person's population. Third finding is that male respondents are more sensitive than female towards the price increment. Furthermore; psychology about purchasing bottled water is found to be same with little variation that purchasing factor is influenced by and mostly dependent on conditions.

To balance the business strategy and minimize the risk of environmental pollution caused by bottled water industry, local water distributors organization needs to apply more and more stringent standardization and supervision as well as to raise up their standards and advertise them by through proper channel to achieve consumers attention and trust in low economy states. For bottled water producers we recommend them to strictly balanced up their products and chemicals compositions by up-to-date improvement of their processing plants, as this is the only way to keep stand in strict competitive environment as consumers are becoming increasingly aware of safety and health concerns and give them priority. Thus perceived and preferred a product by their own judgments, in case of any disruption to their trust will break forever, they can also reject the influence of mass media.

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