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Effect of different herbal infusions on texture of yoghurt on various storage periods

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Abstract

Yoghurt is a widely consumed functional food due to its good taste and nutritional properties. According to FAO/WHO (2003) standards, yoghurt is 'the coagulated milk product obtained by lactic acid fermentation through the action of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*' (Krasaekoopt *et al.*, 2005). Herbal infusions like *Aloe barbadensis* collected from campus of Veterinary College and Research Institute, Namakkal. *Anethum graveolens* purchased from local markets of Kolar district, Karnataka. *Costus igneus* and *Hibiscus Sabdariffa* collected from Horticulture College, GKVK campus, Bangalore were employed in the study. On texture profile analysis significant ($P < 0.05$) increase in hardness, gumminess, chewiness was observed during entire storage period of 21 days in all the yoghurt, whereas the springiness and cohesiveness were found increased up to 14th day and then a gradual decrease on 21st day. A significant reduction in adhesiveness was observed during storage period. A reduction in hardness, gumminess and chewiness on zero day was noticed due to the addition of herbal extracts and a non significance ($p > 0.05$) reduction was observed on storage period.

Keywords: Herbal, yoghurt, storage period, hardness, texture

1. Introduction

Yoghurt is a widely consumed functional food due to its good taste and nutritional properties. According to FAO/WHO (2003) standards, yoghurt is 'the coagulated milk product obtained by lactic acid fermentation through the action of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*' (Krasaekoopt *et al.*, 2005) [2]. The beneficial health effects of yoghurt have been partly linked to the proteolysis products produced during fermentation and storage. During fermentation, LAB produces a range of secondary metabolites, some of which have been associated with health promoting properties of which the notable ones are the B-vitamins and bioactive peptides.

Digestive enzymes, naturally occurring milk enzymes, coagulants and microbial enzymes, especially from adventitious or starter LAB, generate bioactive peptides during milk fermentation and maturation, thereby enriching the dairy products (Korhonen and Pihlanto, 2006) [1]. Upon oral administration, bioactive peptides, may affect the major body systems namely, cardiovascular, nervous, gastrointestinal and immune systems, depending on the inherent amino acid composition and sequence.

Studies indicating that phenolic phytochemicals have high antioxidant activity (Shetty *et al.*, 2005) [5] and certain therapeutic properties including antidiabetic and anti-hypertension activity. These are secondary metabolites of plant origin that constitute one of the most abundant groups of natural metabolites and form an important part of both human and animal diets (Vattem *et al.*, 2005) [6]. This opens the possibility that consumption of select phenolic phytochemicals rich foods may mimic synthetic inhibitors and provide health benefits, but without adverse side effects.

The present study investigate infusion of the commonly used herbs *Aloe barbadensis* (*Aloe vera*), *Anethum graveolence* (dill), *Costus igneus* (insulin plant) and *Hibiscus sabdariffa* (roselle) on yoghurt formation and also to evaluate its textural characteristics in detail.

Materials and methods

Fresh cow milk obtained from the Department of ILFC, Veterinary College and Research Institute, Namakkal – 637 002 was used. Skim milk powder testing 5 and 95 per cent moisture and solubility, respectively was purchased locally (AAVIN). Commercially available good

quality cane sugar was used in the current study. Freeze dried DVS cultures containing yoghurt bacteria *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus salivarius* ssp. *thermophilus* obtained from Chr. Hansen, Denmark, were used in this study. Herbal infusions like *Aloe barbadensis* collected from campus of Veterinary College and Research Institute, Namakkal. *Anethum graveolens* purchased from local markets of Kolar district, Karnataka. *Costus igneus* and *Hibiscus Sabdariffa* collected from Horticulture college, GKVK campus, Bangalore were employed in the study.

Preparation of probiotic yoghurt

Six batches of different herbal probiotic yoghurt were prepared using fresh milk. Skim milk powder at the rate of 2 per cent (w/v) and sugar at the rate of 6 per cent (w/v) were added to it and homogenized at 1000 psi. The contents were mixed well and pasteurized at 85°C for 30 minutes, cooled to room temperature and inoculated with 4 per cent of yoghurt cultures containing *Lactobacillus delbrueckii* subsp. *bulgaricus*, and *Streptococcus salivarius* subsp. *thermophilus*. Different concentrations of herbs were added before incubation and mixed well and incubated at 42°C for 4 to 5 hours and stored at 4°C when the pH was reduced to 4.5. These yoghurts were then placed in the refrigerator for up to 21 days.

Herbal yoghurt

Five different concentrations of herbal yoghurt were prepared from each different herb for standardization and were denoted as

1. PY = Plain yoghurt without adding any herb as a standard yoghurt
2. ABY = *Aloe barbadensis* incorporated yoghurt
3. AGY = *Anethum graveolens* incorporated yoghurt
4. CIY = *Costus igneus* incorporated yoghurt
5. HSY = *Hibiscus sabdariffa* incorporated yoghurt

Different concentrations used for standardization of herbal yoghurt

Table 1: Different concentrations used for standardization of herbal yoghurt

Yoghurt	Concentration of herbs (per cent)				
	0	0	0	0	0
PY	0	0	0	0	0
ABY	12	14	16	18	20
AGY	0.4	0.5	0.6	0.7	0.8
CIY	0.4	0.5	0.6	0.7	0.8
HSY	0.4	0.5	0.6	0.7	0.8

Thus prepared herbal yoghurt was subjected to the different textural based analysis namely Hardness, Adhesiveness, Springiness, Cohesiveness Gumminess and Chewiness.

Storage period used in the current study

For texture profile analysis of yoghurt are zero, 7th, 14th and 21st day are used.

Results

The results obtained from the present study are represented as graphical on texture profile analysis of yoghurt during storage period of zero, 7th, 14th and 21st day are depicted in the figure 1-4 and table 1-7 of all the textural parameters.

Hardness (g) of herbal yoghurt at different storage period

Tables 1. shows the respective mean±SE (g) values of hardness of different herbal yoghurt on zero, 7, 14 and 21 days, which were as follows; PY: 163.42±0.48, 260.11±0.34, 336.49±1.29, and 395.60±0.41; ABY: 134.47±0.48, 186.85±0.67, 256.00±1.74 and 296.00±1.83; AGY: 139.80±0.74, 201.41±0.67, 293.36±1.02 and 293.36±1.02; CIY: 145.52±1.10, 225.03±0.89, 338.41±0.21 and 366.43±0.43, HSY: 150.86±1.10, 223.71±1.39, 324.26±0.48 and 358.35±0.11, respectively.

Table 2: Hardness (g) of herbal yoghurt at different storage period (mean±SE)

Days	PY	ABY	AGY	CIY	HSY	Storage mean±SE
zero day	163.42±0.48	134.47±0.48	139.80±0.74	145.52±1.10	150.86±1.10	146.81 ^d ±0.37
7 th day	260.11±0.34	186.85±0.67	201.41±0.67	225.03±0.89	223.71±1.39	219.42 ^c ±0.86
14 th day	336.49±1.29	256.00±1.74	293.36±1.02	338.41±0.21	324.26±0.48	309.70 ^b ±1.08
21 st day	395.60±0.41	296.00±1.83	351.27±1.43	366.43±0.43	358.35±0.11	353.53 ^a ±1.59
Treatment mean±SE	288.90 ^a ±3.70	218.33 ^e ±2.19	246.98 ^d ±2.78	268.84 ^b ±3.47	264.77 ^c ±3.12	-

^{abcd} means bearing same superscript column wise and row wise was not significant

PY: Plain Yoghurt, AGY: *Anethum graveolens* Yoghurt, ABY: *Aloe barbadensis* Yoghurt

CIY: *Costus igneus* Yoghurt, HSY: *Hibiscus sabdariffa* Yoghurt

Statistical analysis revealed highly significant ($P<0.05$) difference between the treatments for hardness wherein plain yoghurt showed higher value of 288.90±3.70 g compared to AGY, CIY and HSY with the values of 246.98±2.78, 268.84±3.47 and 264.77±3.12, respectively whereas ABY showed the lowest (218.33±2.19) hardness. During storage significant ($P<0.05$) increase in the hardness was observed.

Adhesiveness (g.sec) of herbal yoghurt at different storage period

Tables 2. shows the respective mean±SE values of

adhesiveness (g.sec) of different herbal yoghurts on zero, 7, 14 and 21 days, which were as follows;

PY: -210.71±0.85, -238.74±0.31, -261.64±0.96 and -548.87±0.35; ABY: -172.98±0.61, -224.11±0.62, -263.06±1.31 and -539.98±0.31; AGY: -169.54±0.61, -212.88±0.55, -293.41±1.09 and -543.11±0.41; CIY: -179.57±0.77, -222.35±1.01, -259.18±0.51 and -549.56±0.25, HSY: -178.30±0.97, -205.62±1.80, -261.60±0.33 and -551.99±0.45, respectively.

Table 3: Adhesiveness (g.sec) of herbal yoghurt at different storage period (mean±SE)

Days	PY	ABY	AGY	CIY	HSY	Storage mean±SE
zero day	-210.71±0.85	-172.98±0.61	-169.54±0.61	-179.57±0.77	-178.30±0.97	-182.22 ^a ±0.52
7 th day	-238.74±0.31	-224.11±0.62	-212.88±0.55	-222.35±1.01	-205.62±1.80	-220.74 ^b ±0.42
14 th day	-261.64±0.96	-263.06±1.31	-293.41±1.09	-259.18±0.51	-261.60±0.33	-267.78 ^c ±0.47
21 st day	-548.87±0.35	-539.98±0.31	-543.11±0.41	-549.56±0.25	-551.99±0.45	-546.70 ^d ±0.16
Treatment mean±SE	-314.99 ^d ±5.80	-300.03 ^{ab} ±6.05	-304.74 ^c ±6.16	-302.67 ^{bc} ±6.19	-299.38 ^a ±6.32	-

^{abcd} means bearing same superscript column wise and row wise was not significant

On statistical analysis a significant ($P<0.05$) decrease in adhesiveness was observed during storage period and between treatments HSY showed highest adhesiveness followed by ABY, CIY, AGY and PY.

Springiness of herbal yoghurt at different storage period

Tables 3 shows the respective mean±SE values of springiness

of different herbal yoghurt on zero, 7, 14 and 21 days, which were as follows; PY: 0.89±0.002, 0.92±0.00, 0.96±0.00 and 0.85±0.00; ABY: 0.86±0.001, 0.92±0.001, 0.93±0.002 and 0.83±0.00; AGY: 0.86±0.003, 0.92±0.01, 0.95±0.00 and 0.84±0.00; CIY: 0.89±0.002, 0.91±0.00, 0.95±0.00 and 0.87±0.00, HSY: 0.87±0.01, 0.93±0.00, 0.95±0.00 and 0.87±0.00, respectively.

Table 4: Springiness of herbal yoghurt at different storage period (mean±SE)

Days	PY	ABY	AGY	CIY	HSY	Storage mean±SE
zero day	0.89±0.002	0.86±0.001	0.86±0.003	0.89±0.002	0.87±0.01	0.88 ^c ±0.00
7 th day	0.92±0.00	0.92±0.001	0.92±0.01	0.91±0.00	0.93±0.00	0.92 ^b ±0.00
14 th day	0.96±0.00	0.93±0.002	0.95±0.00	0.95±0.00	0.95±0.00	0.95 ^a ±0.00
21 st day	0.85±0.00	0.83±0.00	0.84±0.00	0.87±0.00	0.87±0.00	0.85 ^d ±0.00
Treatment mean±SE	0.91 ^a ±0.001	0.89 ^b ±0.002	0.89 ^b ±0.002	0.91 ^a ±0.001	0.90 ^a ±0.001	-

^{abcd} means bearing same superscript column wise and row wise was not significant

Statistical analysis revealed significant ($P<0.05$) increase in springiness was observed during storage of 14 days and then reduction in the value was observed on 21st day. Between treatments significantly ($P<0.05$) high springiness was detected in PY, CIY and HSY compared to ABY and AGY.

Cohesiveness of herbal yoghurt at different storage period

Tables 4. shows the respective mean±SE values of

cohesiveness of different herbal yoghurt on zero, 7, 14 and 21 days, which were as follows; PY: 0.59±0.003, 0.64±0.00, 0.66±0.00 and 0.58±0.00; ABY: 0.55±0.00, 0.58±0.002, 0.59±0.01 and 0.56±0.004; AGY: 0.54±0.00, 0.63±0.01, 0.71±0.002 and 0.55±0.003; CIY: 0.55±0.00, 0.62±0.001, 0.70±0.001 and 0.57±0.003, HSY: 0.54±0.004, 0.62±0.01, 0.60±0.001 and 0.57±0.002, respectively.

Table 5: Cohesiveness of herbal yoghurt at different storage period (mean±SE)

Days	PY	ABY	AGY	CIY	HSY	Storage mean±SE
zero day	0.59±0.003	0.55±0.00	0.54±0.00	0.55±0.00	0.54±0.004	0.55 ^d ±0.01
7 th day	0.64±0.00	0.58±0.002	0.63±0.01	0.62±0.001	0.62±0.01	0.62 ^b ±0.001
14 th day	0.66±0.00	0.59±0.01	0.71±0.002	0.70±0.001	0.60±0.001	0.65 ^a ±0.002
21 st day	0.58±0.001	0.56±0.004	0.55±0.003	0.57±0.003	0.57±0.002	0.57 ^c ±0.001
Treatment mean±SE	0.62 ^a ±0.001	0.57 ^b ±0.002	0.61 ^a ±0.003	0.61 ^a ±0.003	0.58 ^b ±0.002	-

^{abcd} means bearing same superscript column wise and row wise was not significant

It was noticed from the statistical analysis that a significantly ($P<0.05$) high cohesiveness was observed in PY, AGY and CIY in comparison with ABY and HSY. It was observed that a significant ($P<0.05$) increase in the cohesive value during storage for 14 days and then gradual reduction in the value was observed in all the yoghurts.

Gumminess of herbal yoghurt at different storage period

Tables 5. shows the respective mean±SE values of

gumminess of different herbal yoghurt on zero, 7, 14 and 21 days, which were as follows; PY: 96.95±0.34, 139.80±0.41, 189.00±0.88 and 231.13±0.47; ABY: 68.78±0.31, 122.61±0.70, 169.99±0.78 and 231.74±0.28; AGY: 69.21±0.28, 133.47±0.58, 191.6±0.53 and 232.54±0.42; CIY: 72.90±0.41, 142.06±0.49, 196.47±0.50 and 235.40±0.22, HSY: 74.42±0.54, 142.94±0.39, 193.47±0.1 and 239.37±0.35, respectively.

Table 6: Gumminess of herbal yoghurt at different storage period (mean±SE)

Days	PY	ABY	AGY	CIY	HSY	Storage mean±SE
zero day	96.95±0.34	68.78±0.31	69.21±0.28	72.90±0.41	74.42±0.54	76.45 ^d ±0.36
7 th day	139.80±0.41	122.61±0.70	133.47±0.58	142.06±0.49	142.94±0.39	136.18 ^c ±0.27
14 th day	189.00±0.88	169.99±0.78	191.6±0.53	196.47±0.50	193.47±0.1	188.11 ^b ±0.34
21 st day	231.13±0.47	231.74±0.28	232.54±0.42	235.40±0.22	239.37±0.35	234.03 ^a ±0.12
Treatment mean±SE	164.22 ^a ±2.15	148.29 ^d ±2.56	156.70 ^c ±2.62	161.70 ^b ±2.60	162.55 ^b ±2.61	-

^{abcd} means bearing same superscript column wise and row wise was not significant

Statistical analysis revealed significantly ($P<0.05$) higher values in PY, HSY and CIY followed by, AGY and ABY and a significant ($P<0.05$) increase in the gumminess was observed during storage period.

Chewiness of herbal yoghurt at different storage period

Tables 6. shows the respective mean±SE values of chewiness of different herbal yoghurt on zero, 7, 14 and 21 days, which

were as follows; PY: 87.51±0.43, 137.23±0.35, 183.21±0.89 and 195.43±0.21; ABY: 81.68±0.26, 117.92±0.36, 171.43±1.00 and 196.60±0.21; AGY: 82.49±0.41, 145.32±0.46, 185.04±0.39 and 195.14±0.33; CIY: 80.63±0.42, 140.36±0.51, 184.83±0.38 and 199.16±0.29, HSY: 80.85±0.78, 142.02±0.51, 184.00±0.43 and 196.04±0.27, respectively.

Table 7: Chewiness of herbal yoghurt at different storage period (Mean ± SE)

Days	PY	ABY	AGY	CIY	HSY	Storage mean±SE
zero day	87.51±0.43	81.68±0.26	82.49±0.41	80.63±0.42	80.85±0.78	82.63 ^d ±0.13
7 th day	137.23±0.35	117.92±0.36	145.32±0.46	140.36±0.51	142.02±0.51	136.57 ^c ±0.34
14 th day	183.21±0.89	171.43±1.00	185.04±0.39	184.83±0.38	184.00±0.43	181.70 ^b ±0.22
21 st day	195.43±0.21	196.60±0.21	195.14±0.33	199.16±0.29	196.04±0.27	196.47 ^a ±0.07
Treatment mean±SE	150.84 ^a ±1.81	141.91 ^b ±1.92	152.00 ^a ±1.89	151.23 ^a ±1.97	150.73 ^a ±1.93	-

^{abcd} means bearing same superscript column wise and row wise was not significant

Statistically, significantly ($P<0.05$) increases in the values of chewiness were observed storage period and ABY showed significantly ($P<0.05$) lower chewiness compared to all other treatments.

Economics of preparation of herb incorporated functional yoghurt

The cost of production of plain and different types of herbs incorporated yoghurts are presented in table 7.

Table 8: Economics of preparation of herbal yoghurt (in Rupees)

Treatments	Cost of milk	Cost of SMP	Cost of Processing	Cost of herbal extraction	Cost of cups	Cost of sugar	Cost of cultures	Cost of production per litre
PY	30	4.8	1	0	8	1.8	0.5	46.1
AGY	30	4.8	1	2	8	1.8	0.5	48.1
CIY	30	4.8	1	1.5	8	1.8	0.5	47.6
HSY	30	4.8	1	5	8	1.8	0.5	51.1
ABY	30	4.8	1	1	8	1.8	0.5	47.1

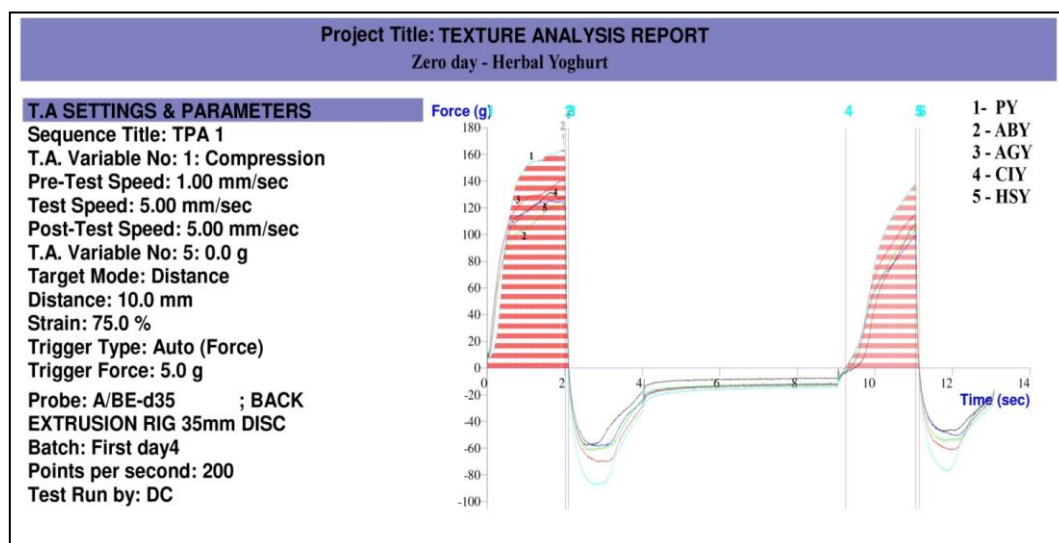


Fig 1: Texture profile analysis of herbal yoghurts on zero day

The production cost of different treatments of yoghurt ranged from Rs. 46.1 to 51.1. Cost of production per litre of all the

herbal yoghurts was higher than the plain yoghurt. Production cost was highest in HSY and lowest in PY.

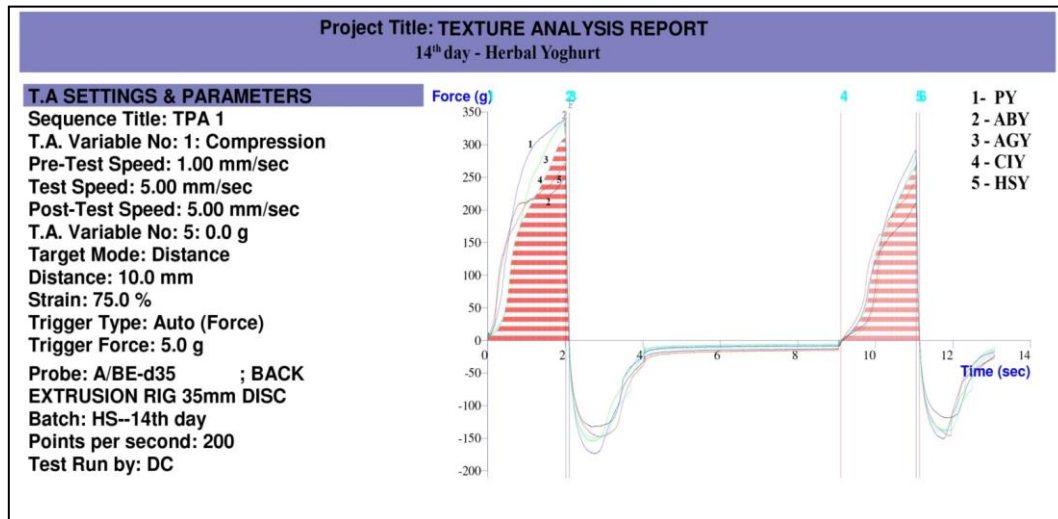


Fig 2: Texture profile analysis of herbal yoghurts on Seventh day

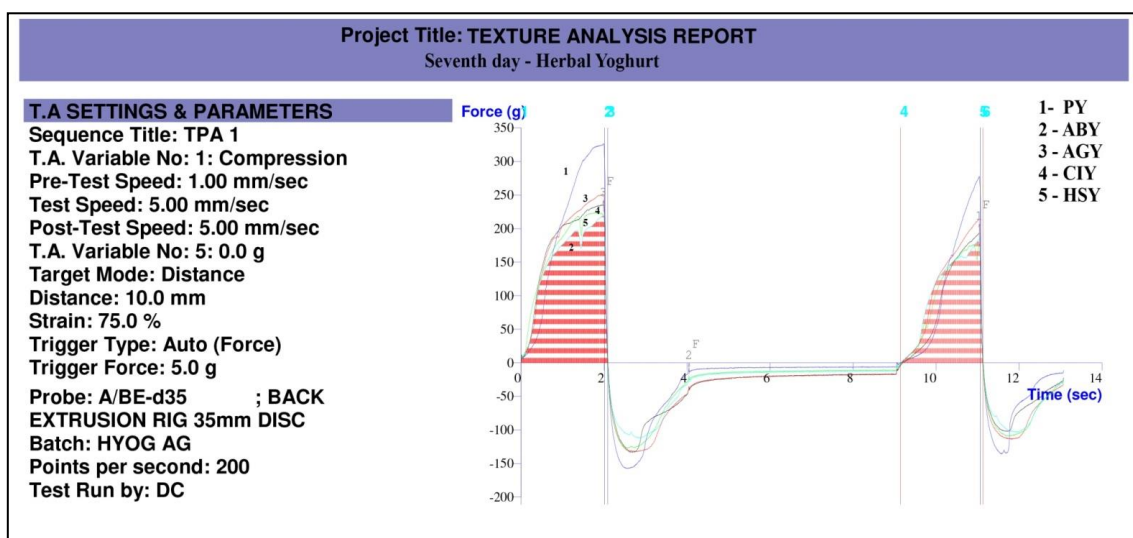


Fig 3: Texture profile analysis of herbal yoghurts on Fourteenth day

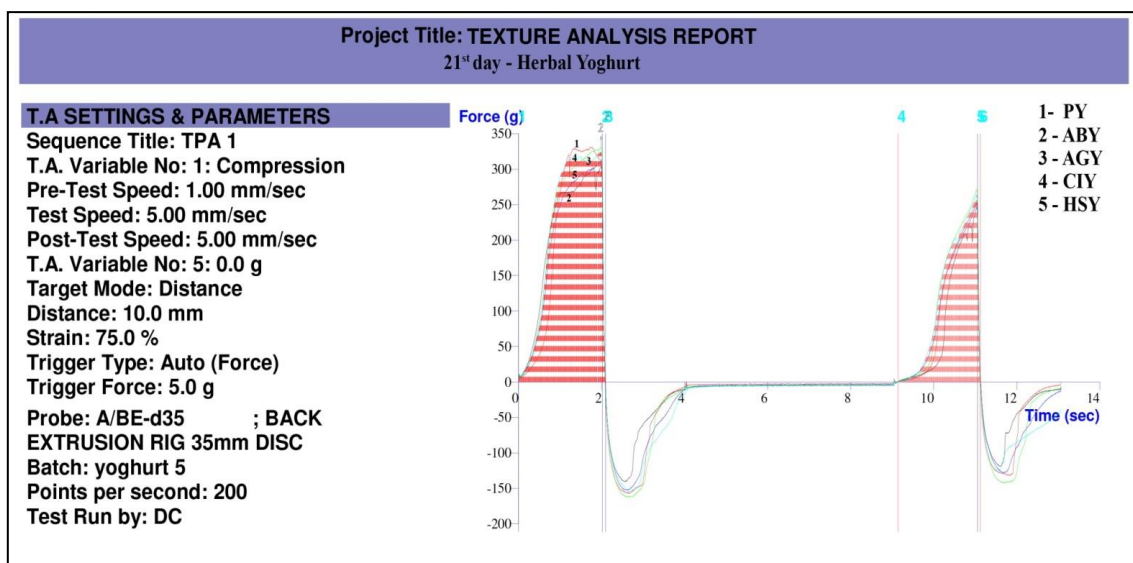


Fig 4: Texture profile analysis of herbal yoghurts on Twenty first days

Discussion

Textural properties of the yoghurt

Texture profile analysis results reveal that addition of herbs in to the yoghurt increases hardness, gumminess and chewiness

and decrease adhesiveness during storage period whereas increase in springiness and cohesiveness were observed on 14th day with gradual reduction towards 21st day.

All these results are supported by previous results of Rasdhari

et al. (2008) [4] studied textural properties of *H.sabdariffa* and *L.casei* incorporated probiotic yoghurt by using TA XT texture analyser. Increase in stickiness, consistency, firmness and index of viscosity values were observed in herb incorporated yoghurt over control yoghurt.

Yang and Li (2010) [7] observed improved hardness and gumminess on addition of soya to yoghurt with reduced springiness and cohesiveness on comparison with reconstituted skimmed milk yoghurt which showed lower hardness, gumminess, springiness and cohesiveness.

The variations in textural parameters of herbal and plain yoghurt may be attributed to the variation in the level and duration of acid production and other physicochemical changes that occur during fermentation and storage of yoghurt due to addition of herbs.

Economics of preparation of herb incorporated functional yoghurt

The cost economics for the productions of different herbal yoghurts was calculated based on the existing market price of the raw materials. Higher cost of the HSY may be due to higher cost of herb *H. sabdariffa* compared to the cost of other herbs. Since no herb is added to PY the production cost of the PY remained low. Hence, the range of herbs usage in yoghurt can be considered as versatile for their great functional health benefits with better flexible costs.

Conclusion

On texture profile analysis significant ($P < 0.05$) increase in hardness, gumminess, chewiness was observed during entire storage period of 21 days in all the yoghurt, whereas the springiness and cohesiveness were found increased up to 14th day and then a gradual decrease on 21st day. A significant reduction in adhesiveness was observed during storage period. A reduction in hardness, gumminess and chewiness on zero day was noticed due to the addition of herbal extracts and a non significance ($p > 0.05$) reduction was observed on storage period. The production cost of different treatments of yoghurt ranged from Rs.46.1 to 51.1. Production cost was highest in HSY and lowest in PY.

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