Physicochemical, Microbiological and Sensory Characterization of Halloumi Cheese Fortified with Garlic (*Allium sativum*) and Pepper (*Piper nigrum*)

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✓**Halloumi cheese ?**

1

✓Rising awareness on the health benefits of Halloumi cheese ?

2

3

✓Market trends?

Global Halloumi Cheese market < USD 454.7 million in 2021.

The market is further expected to grow in the forecast period of 2023-2028 at a CAGR of 10.5% to reach over USD 827.7 million by 2027.

Objectives

- To develop a cow's milk Halloumi cheese fortified with Garlic and Pepper

- To evaluate the,

✓ physicochemical properties
✓ microbiological shelf life and
✓ consumer perception,
of Halloumi cheese fortified with Garlic and Pepper

Manufacturing Process

01

Preparation of Pepper & Garlic powder

Pepper & Garlic powder was mixed after oven drying and powdering

02

Pasteurization of the cow milk

Cow milk was pasteurized and cooled to coagulation temperature

03

Add $CaCl_2$ & Rennet

After coagulation, curd were placed in mold and pressed until whey was removed

04

Heat the curd by placing in whey solution

Curds were heated to a temperature about 80 ^{o}C for at least 15 min

05

Salting & adding the Garlic & pepper powder

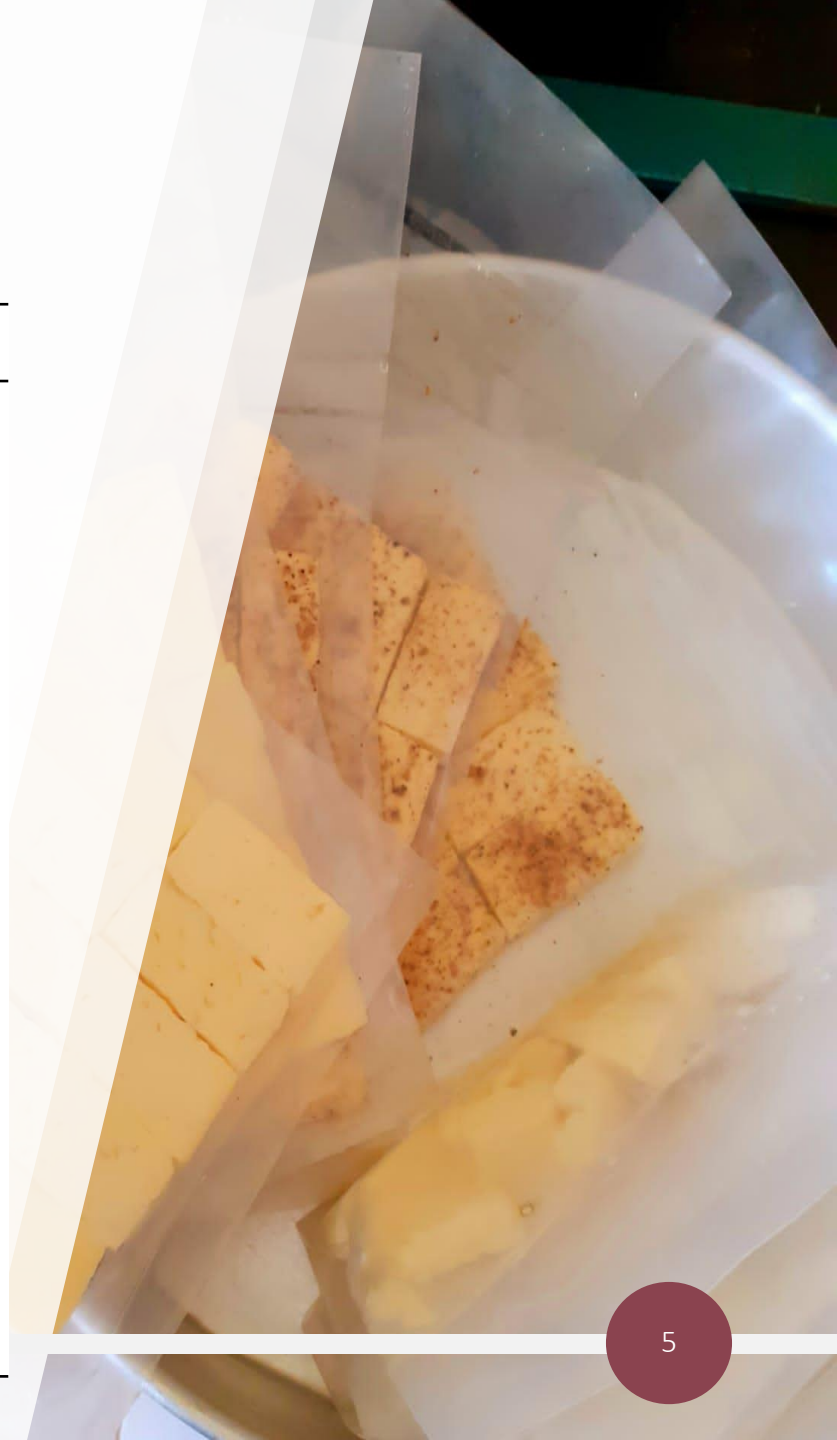
Curd were Kept in 15% brine solution for 1hour

Finally Garlic & Pepper powder were added on the surface

Physicochemical Analysis

Table 1: Measured Physicochemical Parameters & Methods

Parameter	Method
Total solid (%)	Oven Dry (105^0C, 16hrs)
Protein (%)	Kjeldahl
Fat (%)	Soxhelt
Moisture (%)	Oven Dry (105^0C, 3hrs)
Ash (%)	Muffle Furner
pH	pH Meter
Textural properties	
Cohesiveness	TX 700 Texture Analyzer
Hardness	
Chewiness	
Gumminess	
Color parameters	
L value, a value, b value	Hunter Lab colour Meter

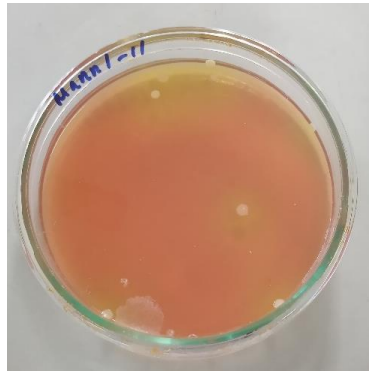


Microbiological Analysis

1. Halloumi cheese sample preparation

2. Serial dilution

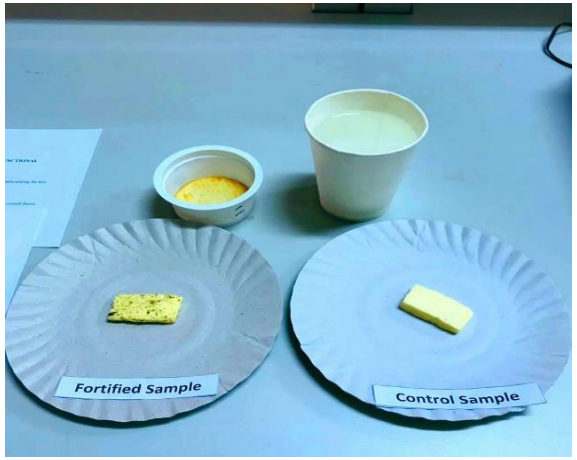
3. Microbiological examination



4. Determination of the shelf life of the sample

Sensory Evaluation

- Control Sample (nonfortified sample)
- Fortified Sample (with a mixture of garlic & pepper powder)



- 30 participants
- 20-30 years old

- XL STAT
- SPSS Software

Results and Discussion

Physicochemical Analysis

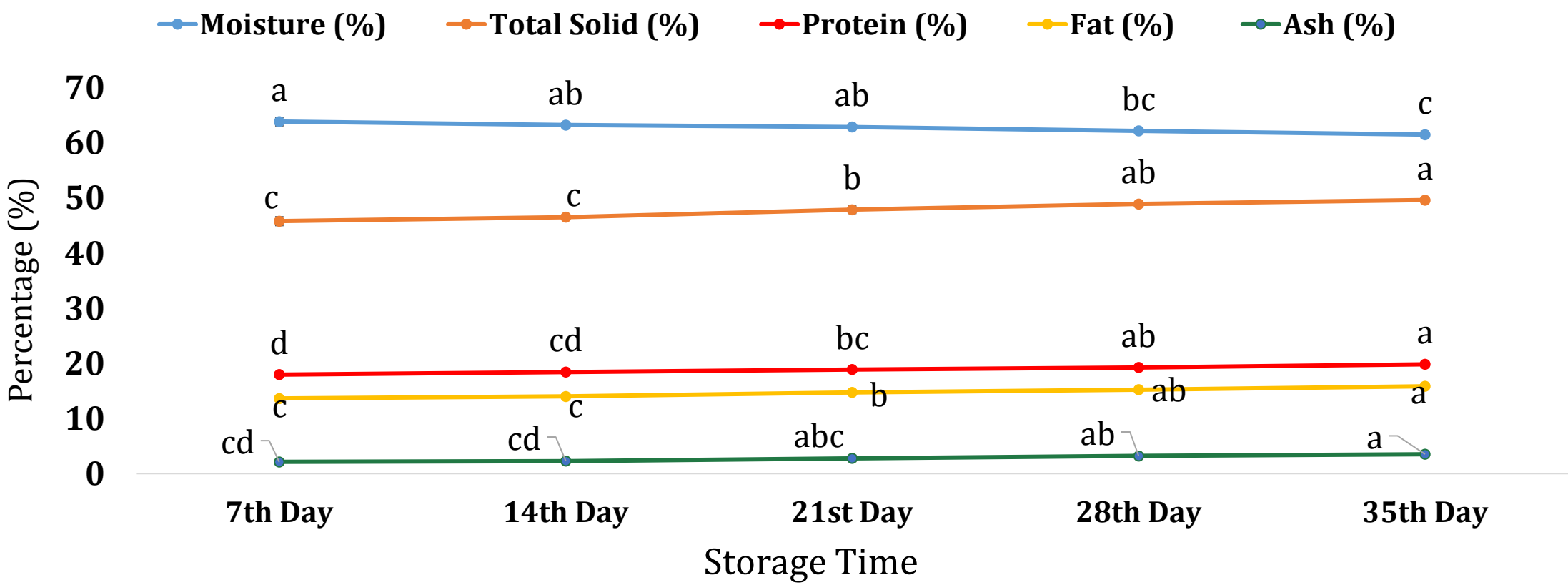


Figure 1. Chemical composition of Halloumi Cheese during the storage time

- There was a significant different ($p < 0.05$) for moisture, total solid, protein, fat, ash content between the cheese samples with storage time.

Physicochemical Analysis Con.

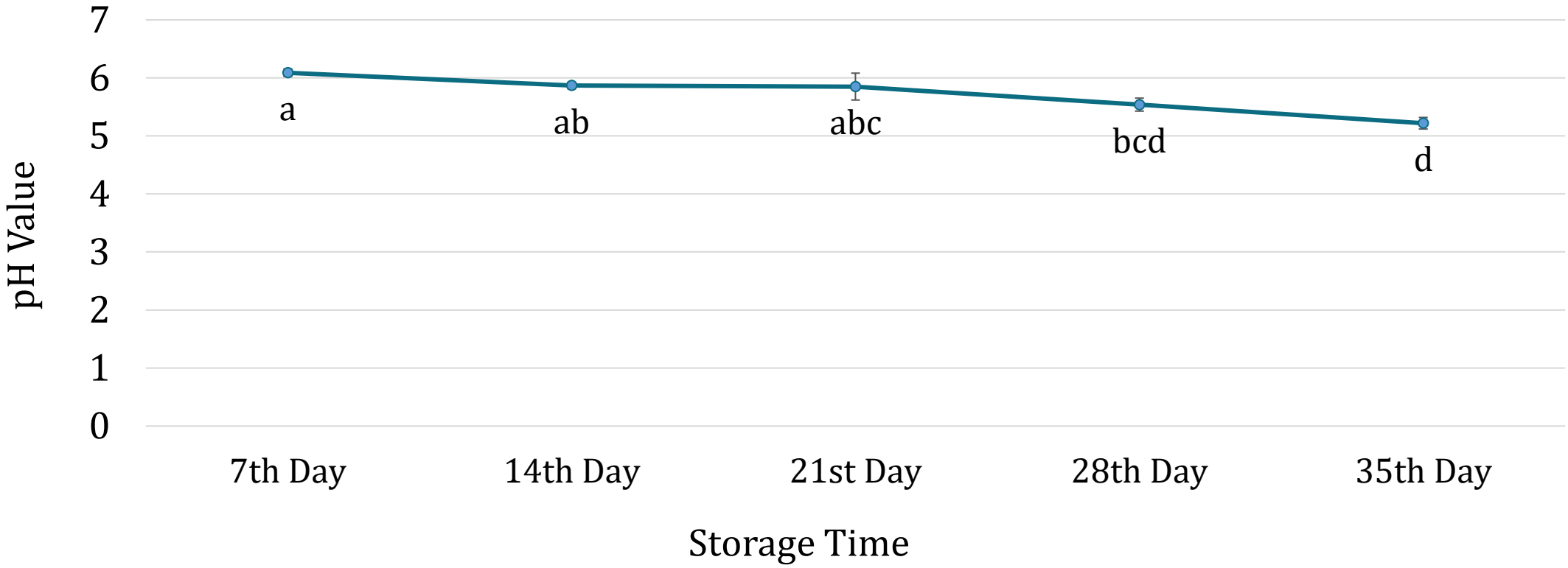


Figure 2. pH value of Halloumi Cheese during the storage time

- There was a significant different ($p < 0.05$) for pH value between the cheese samples with storage time.

Texture Profile Analysis

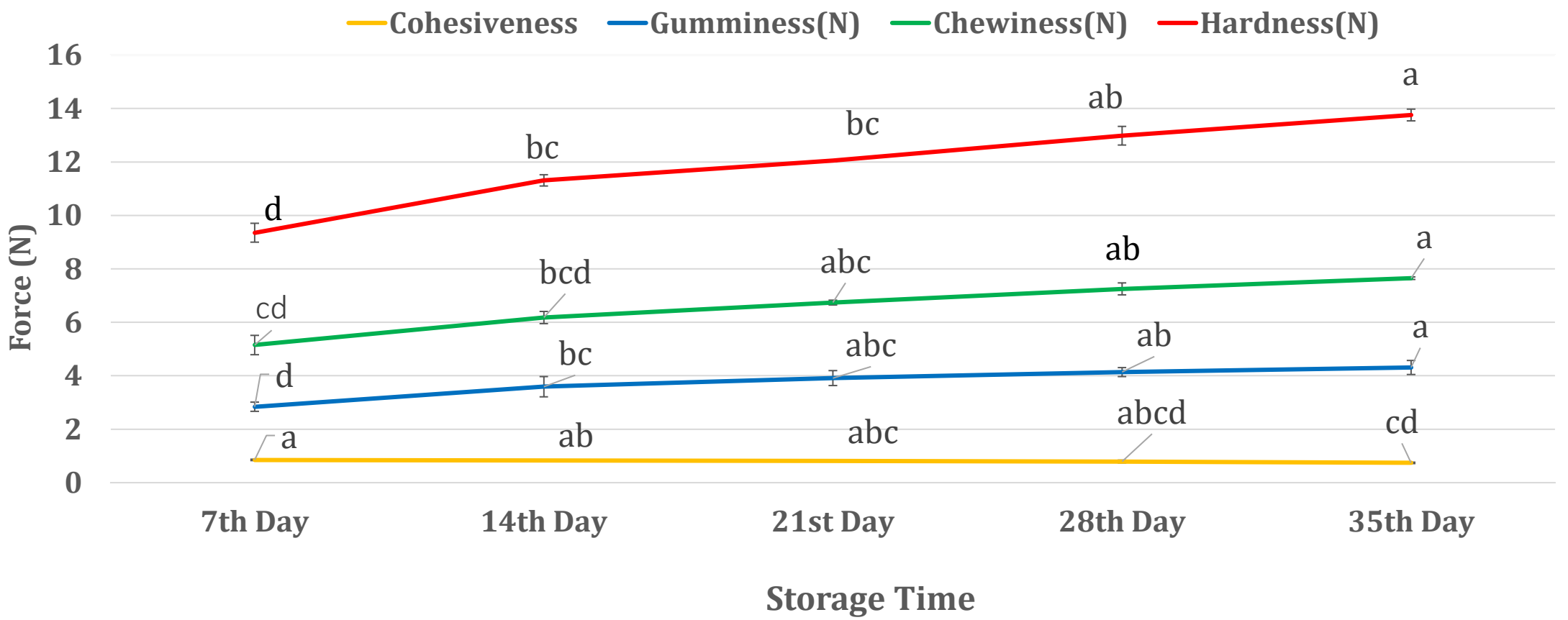


Figure 3. Texture Profile Analysis of Halloumi Cheese during the storage time

- There was a significant different ($p < 0.05$) for Hardness, Chewiness, Gumminess, Cohesiveness between the cheese samples with storage time.

Colour Analysis

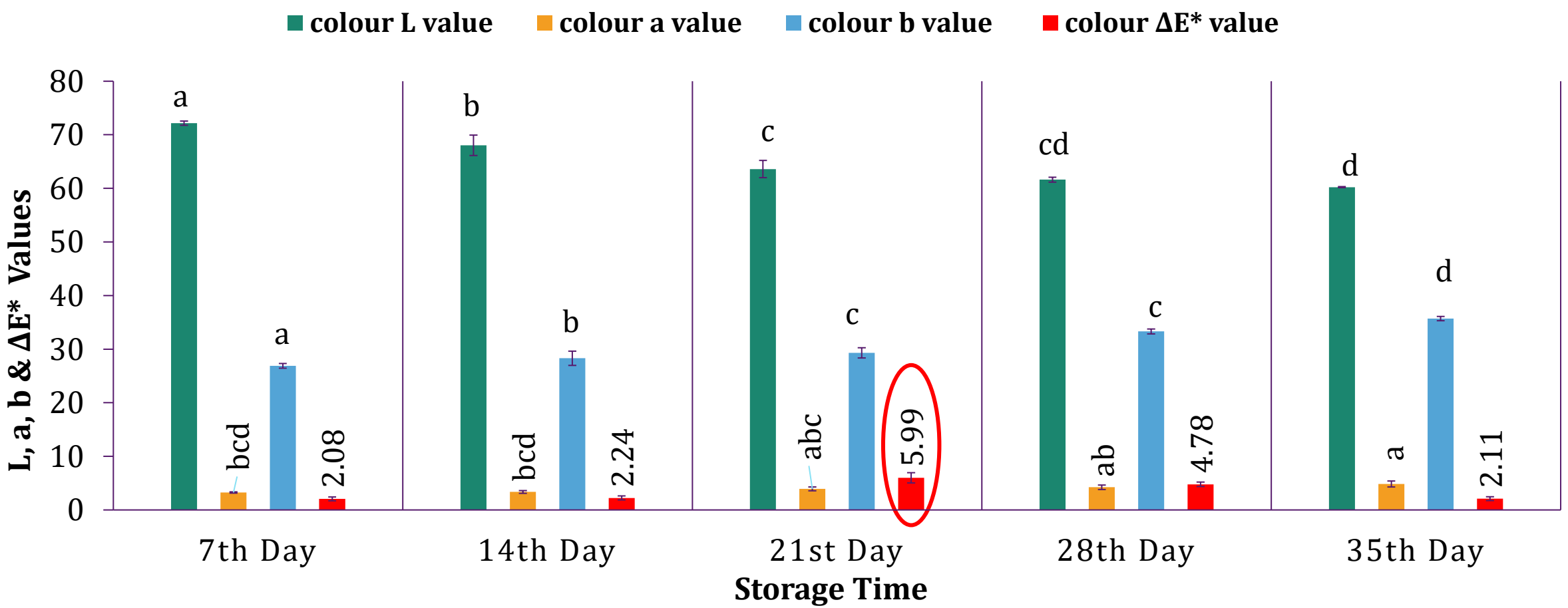


Figure 4. Colour characteristics of Halloumi Cheese during the storage period

- There was a significant different ($p < 0.05$) for L value, a value, b value between the cheese samples with storage time.

Microbiological Analysis

Total bacteria count

Table 2: Microbial count of total bacteria during storage time

Storage time (Days)	Microbial count of total bacteria (log CFU/g)
1	2.51±0.03^{d}
10	2.71±0.09^{c}
20	2.70±0.02^{c}
30	3.77±0.05^{b}
40	4.78±0.02^{a}

Values followed by different superscript letters indicate significant differences; tukey's test (P<0.05)

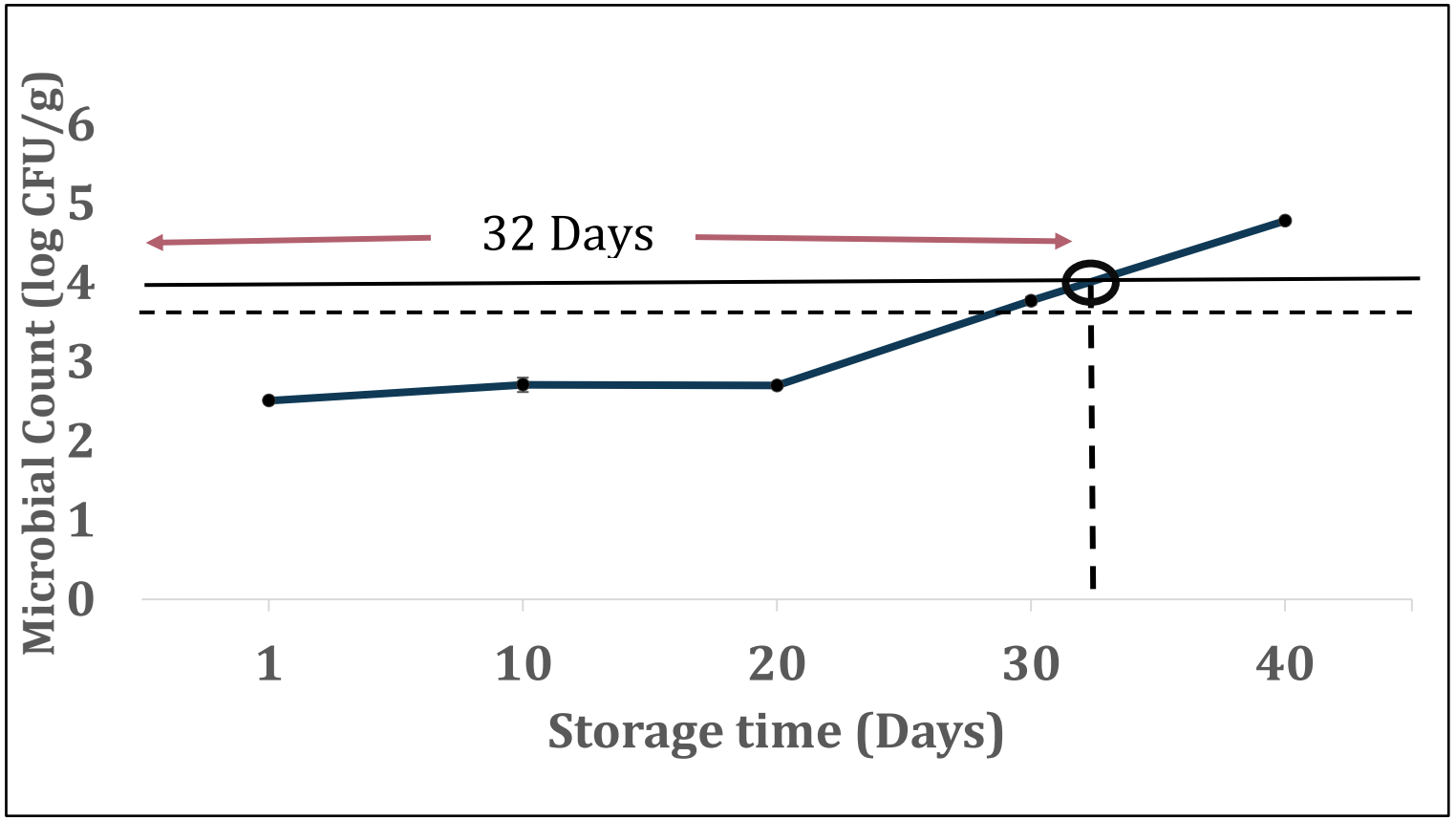


Figure 5. Growth curve of total bacteria during storage time
Maximum permissible limit of total bacteria
Minimum permissible limit of total bacteria
Total bacteria count of current study

E. coli count

Table 3: Microbial count of *E. coli* during storage time

Storage time (Days)	Microbial count of *E. coli* (log CFU/g)
1	0.00 ± 0.00^{d}
10	1.00 ± 0.00^{c}
20	1.20 ± 0.17^{c}
30	1.88 ± 0.03^{b}
40	2.16 ± 0.02^{a}

Values followed by different superscript letters indicate significant differences; tukey's test ($P<0.05$)

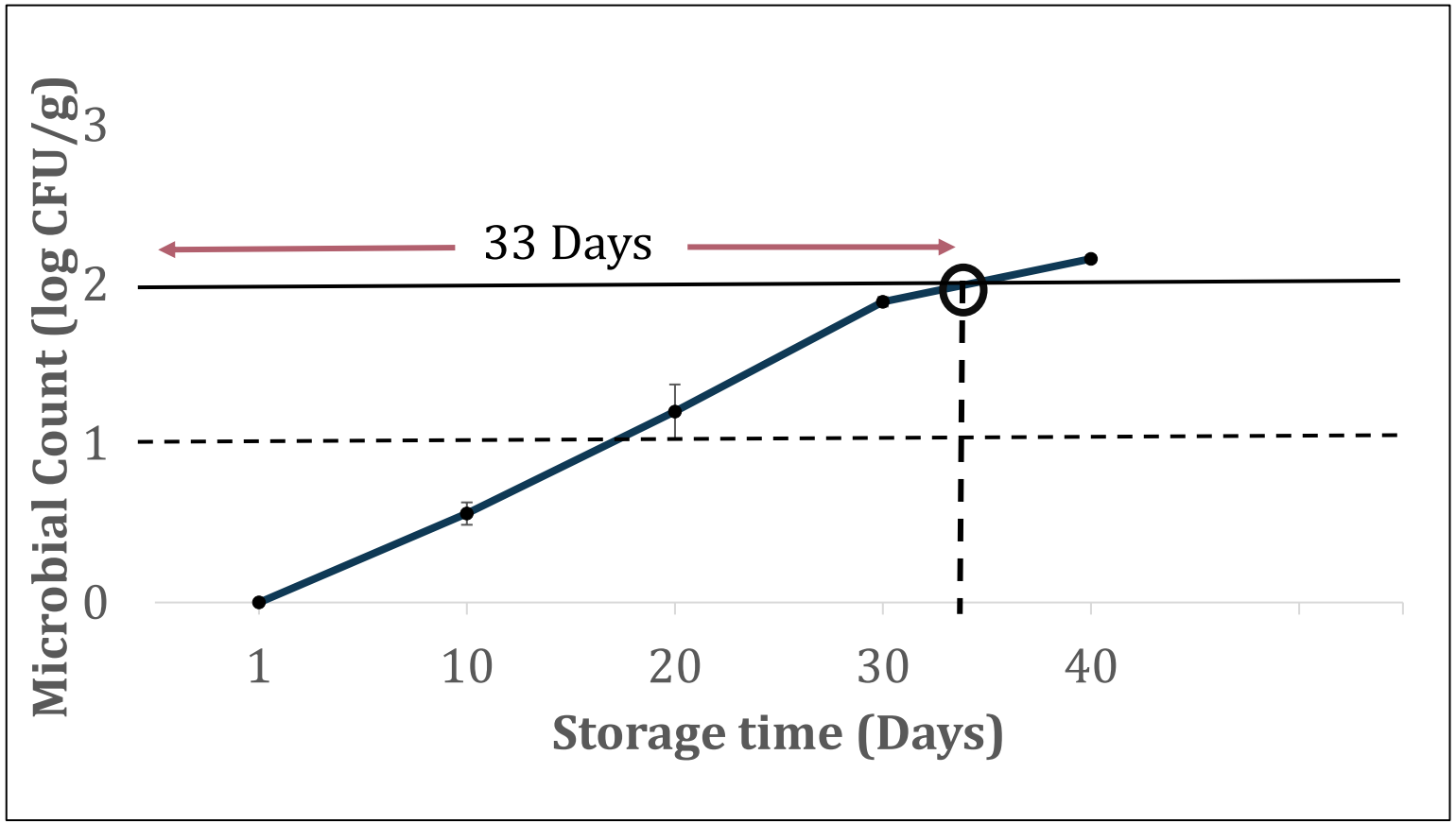


Figure 6. Growth curve of *E. coli* during storage time
Maximum permissible limit of *E. coli*
Minimum permissible limit of *E. coli*
E. coli count of current study

Yeasts and molds count

Table 4: Microbial count of yeasts & molds during storage time

Storage time (Days)	Microbial count of yeasts & molds (log CFU/g)
1	0.00 ± 0.00^{e}
10	1.10 ± 0.17^{d}
20	1.42 ± 0.10^{c}
30	1.92 ± 0.08^{b}
40	2.30 ± 0.04^{a}

Values followed by different superscript letters indicate significant differences; tukey's test (P<0.05)

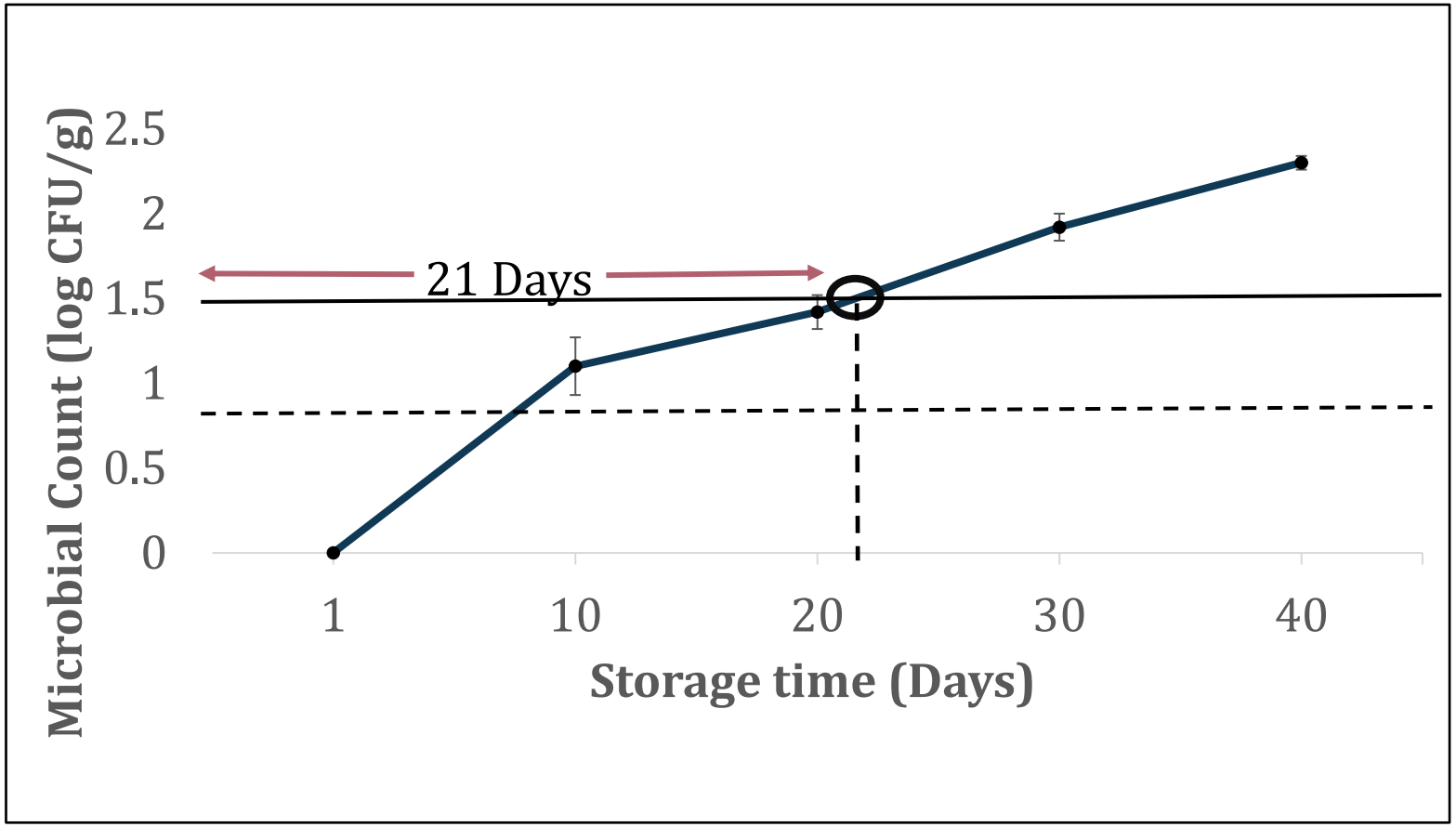


Figure 7. Growth curve of yeasts and molds during storage time
Maximum permissible limit of yeasts and molds
Minimum permissible limit of yeasts and molds
Yeasts and molds count of current study

S. aureus count

Table 5: Microbial count of *S. aureus* during storage time

Storage time (Days)	Microbial count of *S. aureus* (log CFU/g)
1	1.92±0.03[a]
10	1.63±0.13[b]
20	1.59±0.11[bc]
30	1.59±0.11[bcd]
40	1.36±0.10[bcd]

Values followed by different superscript letters indicate significant differences; tukey's test (P<0.05)

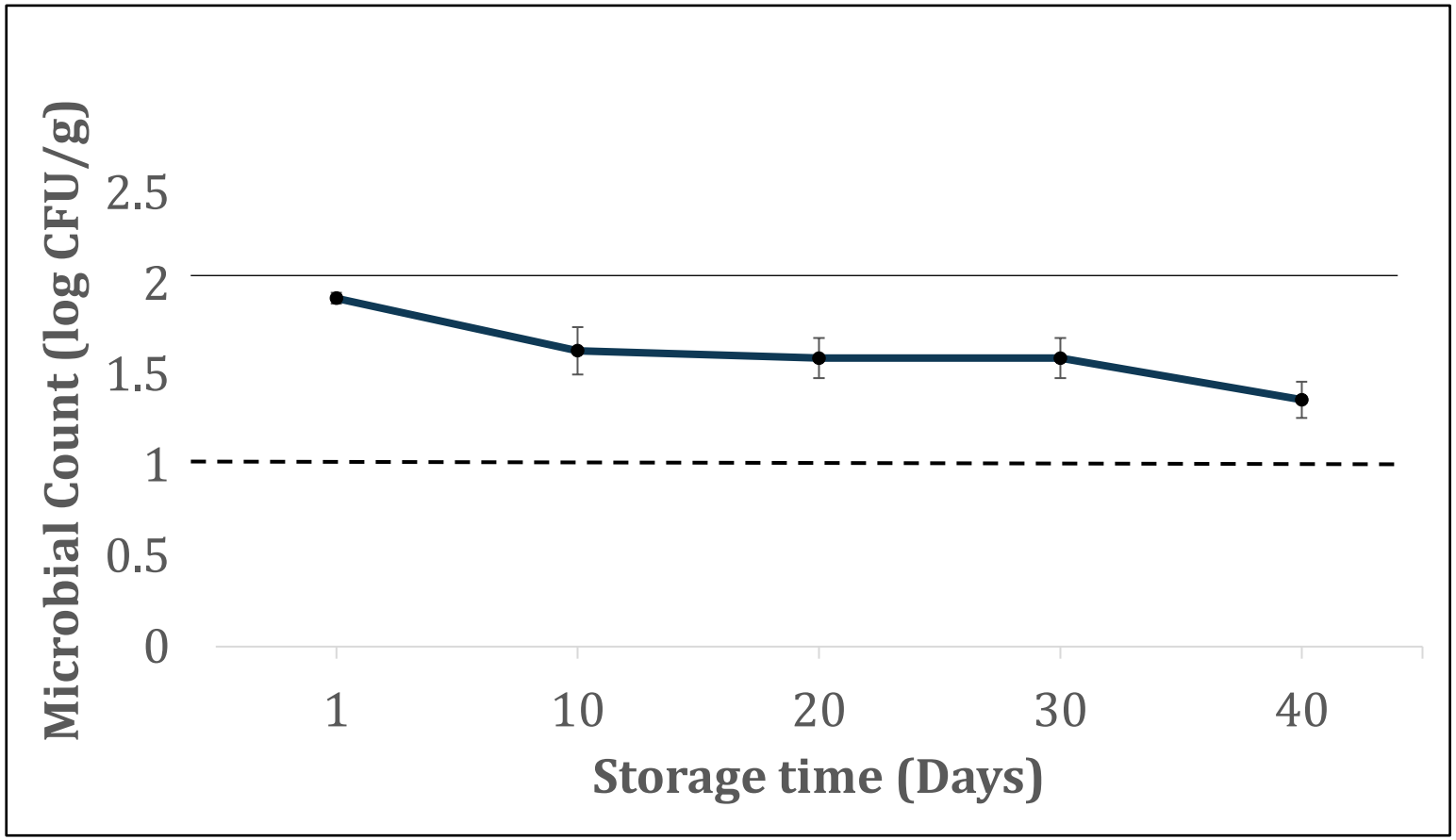


Figure 8. Growth curve of *S. aureus* during storage time
Maximum permissible limit of *S. aureus*
Minimum permissible limit of *S. aureus*
S. aureus count of current study

LAB count

Table 6: Microbial count of LAB during storage time

Storage time (Days)	Microbial count of LAB (log CFU/g)
1	0.00±0.00^{d}
10	2.49±0.01^{c}
20	2.53±0.01^{c}
30	2.68±0.02^{a}
40	2.62±0.02^{b}

Values followed by different superscript letters indicate significant differences; tukey's test (P<0.05)

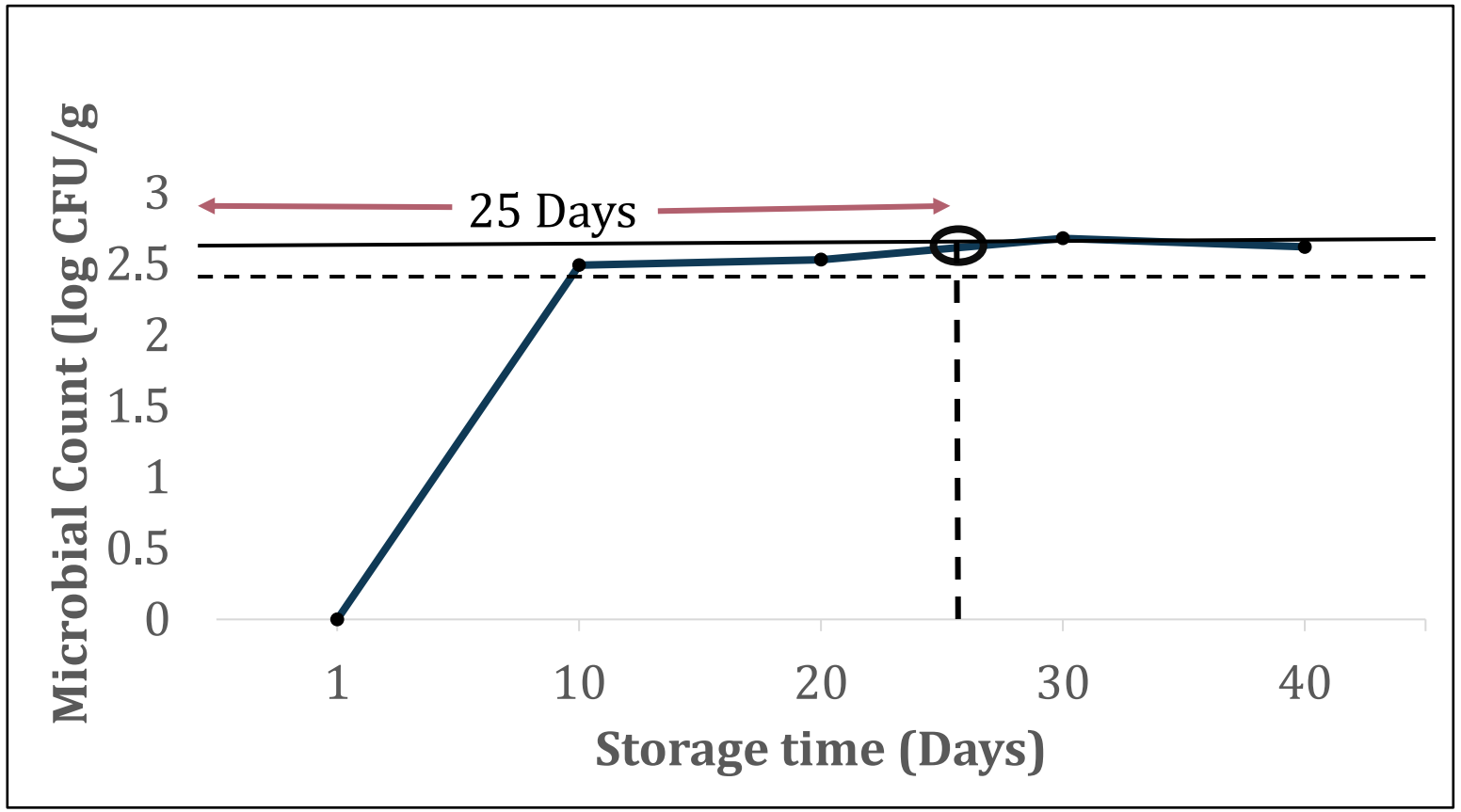


Figure 9. Growth curve of LAB during storage time
Maximum permissible limit of LAB
Minimum permissible limit of LAB
LAB count of current study

Sensory Analysis

Liking scores

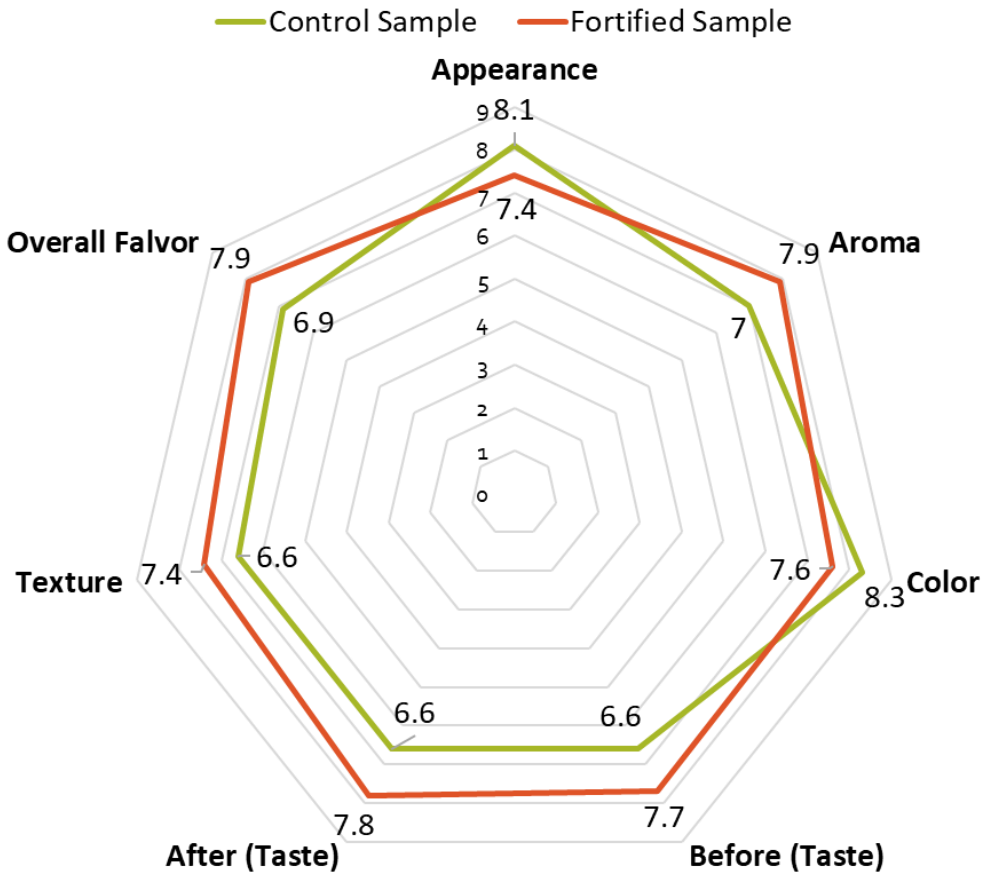


Figure 10. Spider chart for consumer preference mean scores.

Conclusion

- pH value and moisture content of samples significantly declined and total solid, fat, protein and ash content were significantly increased with storage time.
- Lightness of samples (L*) significantly declined and yellow tone (parameter b*) and red tone(a*) were more pronounced during storage time.
- Cohesiveness of the sample significantly declined and Gumminess, Chewiness and Hardness were significantly increased with storage time.
- Microbiological Shelf life of Halloumi cheese – 21 days at 10℃
- Halloumi cheese fortified with garlic (*Allium sativum L*) & pepper (*Piper nigrum L*) powder mixture improve the consumer preference by aroma, taste , texture & overall flavor.

References

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- Stone, H. and Sidel, J.L., 2004. Introduction to sensory evaluation. *Sensory Evaluation Practices (Third Edition). Academic Press, San Diego*, pp.1-19.

THANK YOU