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Optimization and development of probiotic goat milk kiwi fruit enriched functional yoghurt

Akhilesh Kumar Singh, Manoj Kumar and Manvendra Singh

Abstract
Yoghurt recognized as a healthy and multifunctional food. It is a coagulated milk product obtained from the lactic acid fermentation by the action of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. In this present studies, kiwi fruit extract was added in milk and their effects during yogurt fermentation were investigated. The changes in pH and Titratable Acidity (TA) were measured during fermentation and after 20 days of storage at 5 °C. The yogurt extracts were subsequently analysed for their syneresis, proteolysis, peptide content, total phenolic content, antioxidant activities, inhibitory activities on α-amylase and α-glucosidase, presence of exo polysaccharides (EPS) and organoleptic properties. pH values for both dragon fruits yogurt showed significant reduction while titrabel acidity showed higher percentages compared to plain-yogurts during fermentation and after days of storage. Syneresis in yogurt (27.93%) also has been increased (p>0.05) with the addition of kiwi fruit compared to the control (29.67%) The total phenolic content (TPC) in kiwi fruit yogurt (36.44-64.43 ug GAE/ml) showed a greater increase (p<0.05) than plain yogurt (20.25 ug GAE/ml). Kiwi showed the highest score for visual appearance (7.77), aroma (5.9) and sweetness (4.22) while plain yogurt showed highest scores for body texture (6.81), sourness (7.13) and overall taste (5.45). In conclusion, the addition of kiwi fruit in yogurt gave enhanced effects on physicochemical, therapeutic properties, production of EPS and organoleptic properties in Yoghurt.

Keywords: Goat milk, kiwi pulp, probiotic, yoghurt, functional, syneresis

1. Introduction
Milk can be termed as a perfect or complete food for human body as it is a source of proteins, fats, sugars, vitamins and minerals. Now days, due to recent technological developments in the dairy industry, variety of milk products have been introduced in the market with different tastes & nutritional benefits. Milk being perishable commodity, can be preserved either by converting into concentrate, or can be transformed into dried products or fermented products like, curd, yoghurt, acidophilus milk etc. As regular milk is a major source of animal proteins and other nutrients, fermented milk products plays an important place in the diet of Indian people as majority of the population here are vegetarian (Shukla *et al*., 1987) [22].
Yoghurt with no added flavours is predominantly sour due to the lactic acid produced during fermentation. For the acceptance of such yoghurt by the consumers, fruit flavourings and sweeteners have been added to improve the flavour balance or to mask partially the acetaldehyde flavour characteristics (Bills *et al*., 1972) [4]. In preparation of low fat yoghurt, skim milk powder is added to increase the total solids content. The use of cereals with high protein content plays a significant role as a partial substitute for milk solids (Rasic and Kurmann, 1983) [20]. Low total solids in yoghurt without any protein fortification can result in whey expulsion, weak body, poor texture, and inconsistent product over time. In order to resolve these problems, yoghurts are generally fortified with different types of stabilizers to improve stability, thickness, and gelling properties. However, adding stabilizers is not a common practice in many countries where yoghurt is manufactured (Tamime, Kalab, and Davies, 1984) [26].
Actinindia chinensis Planch. *var. deliciosa* is known as kiwifruit or Chinese gooseberry. Fruit is edible, good keeping health; used for making wine, jam and marmalade; also employed for decorating icecreams. A Chinese plant with economic potential in India; introduced from New Zealand, showed promise in Himachal Pradesh. This variety name was first published in Rev. Bot. Appl. Agric. Trop., 21: 241(1941). This was also referred by Chopra *et al*. (1986) [31] in The Useful Plants of India," Published by Council of Scientific andIndustrial Research, Govt. of India. *Actinidia deliciosa* is now a synonym of this valid name of kiwifruit.

2. Materials and Method

Goat milk (protein 3.32%, moisture 87.52%, fat 4.16% and ash 0.74%) were procured from the Department of dairy, Banaras Hindu University, Varanasi. and kiwi fruit were procured from local market, sunderpur, Varanasi.Yoghurt culture YC-381 (CHR Hansen) Other raw material including cup (Polyproplene). Reagents for analytical study were procured from Merc, Himedia and Sigma-aldrich, USA.For the development of yoghurt (Tamime and Deeth, 1980) [25] and (Zourari *et al*, 1992) [30].

2.1 Preparation of functional Yoghurt

The Goat milk heated to 40 °C, kiwi fruit extract was added at concentrations of 1-2.0 ml mixed with a mechanical stirrer, pasteurised at 90 °C for 10 min in a water bath and cooled to 45 °C. After inoculation with the appropriate inoculum type, milk was distributed to 1000 mL sterilised plastic containers, they were sealed, incubated at 37 °C, for 4 h and then cooled and stored at 4 °C. Yoghurt samples were subjected to microbiological and physicochemical analysis. Types of inocula and conditions used were as follows: inoculation with yoghurt starter cultures (L. delbrueckii subsp. bulgaricus and S. thermophilus) was same in all samples.FDA.2013a. Yogurt. 21 CFR 131.200, Code of Federal Regulations. U. S.Dept. of Health and Human Services, Washington, DC Lucey, J.A. Teo, C.T. Munro, P.A. and Singh, H. (1997) [15], (Lucey and Singh, 1998) [14] and The bacilli to cocci ratio in yoghurt starter culture is 1:1 (Wouters *et al*. 2002; Sokolinska and Pikul, 2004) [28, 23].

2.2 Physicochemical analysis of kiwi fruit rich yoghurt

The pH values were determined with the help of an electronic pH meter (Thermo Scientific, 2 stars), Acidity of various samples was determined by titrating against 0.1N NaOH according to AOAC (1995) method. The total phenolic content was determined by the Folin-Ciocalteau method (Kaur & Kapoor, 2002) [34]. The DPPH radical scavenging assay was based on the previous method (Michalska *et al*. 2007) [32].

2.3 Determination of sensory qualities

Sensory quality attributes *viz*. colour and appearance; consistency, flavour, taste and overall acceptability of the samples were evaluated using a 9-point hedonic rating test by a panel of six judges by the method recommended by Ranganna (2001).

2.4 Statistical analysis

The data obtained from the various experiments were recorded and subjected to statistical analysis as per the Analysis of Variance method of Factorial Complete Randomized Design (CRD). The significance and non-significance of data obtained from various experiments were judged with the help of an F (variance ratio) Table. The significant difference between the means was tested against the critical difference at the 1% and 5% level of significance by using STPR software for data analysis.

3. Results

Table 1: Physicochemical properties of raw goat milk

Fatty Acids	Goat milk
pH	6.7
Acidity	0.17
Moisture	87.52
Fat	4.16
Protein	3.32
Ash	0.74
Carbohydrate/lactose	4.26
SNF	8.37

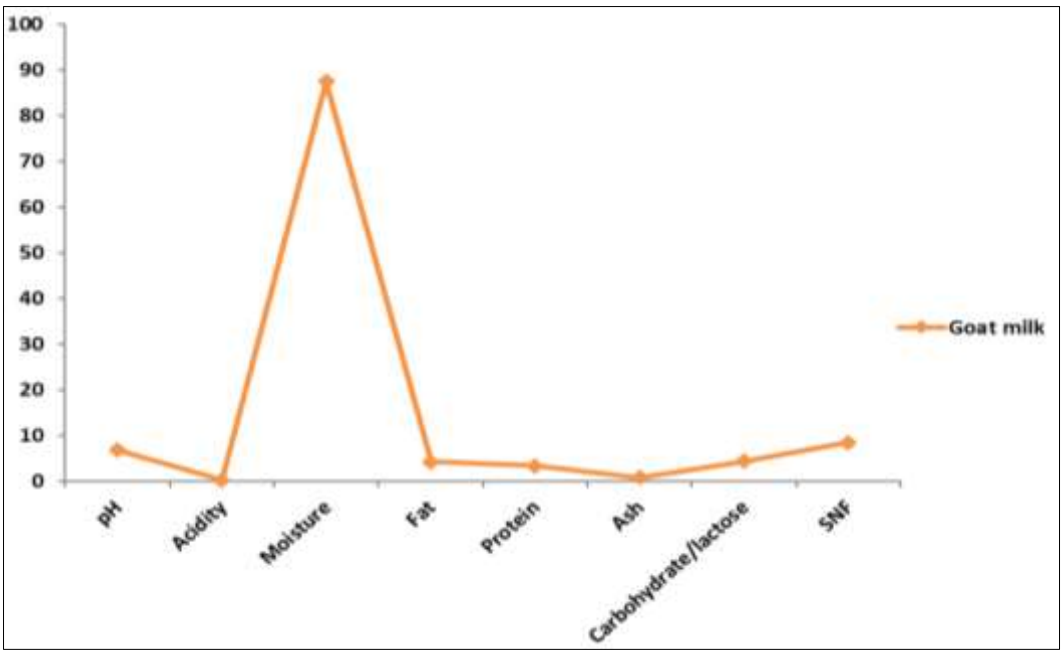

Fig 1: Physicochemical properties of raw goat milk

4.1 Flavour

According to data functional yoghurt is increased after mixing with kiwi fruit extract in comparison to milk content Fig.2. The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20 sample T1, T2, T3, etc. According to organoleptic test of flavour is highest value of T7, T12, T16, 9.0. and gradually decreased value of treatment of T1, T3 & T5 is 8.0. The lowest value of flavour T4 and T8 is 6.0. Table 3. The statistical significant value (p>0.005) and standard deviation (σ=0.021), R^2 is 0.89. The similar data are found Nejad, J. H., Sani, A. M., & Hojjatoleslamy, M. (2014) [9]. in which own research in functional Yoghurt of flavour 8.9 during organoleptic test. According to Matter, A., Mahmoud, A. M., & Zidan, N. S. (2016) [18] are found in papaya flavoured yoghurt in flavour content is 8.5 by found by organoleptic test.

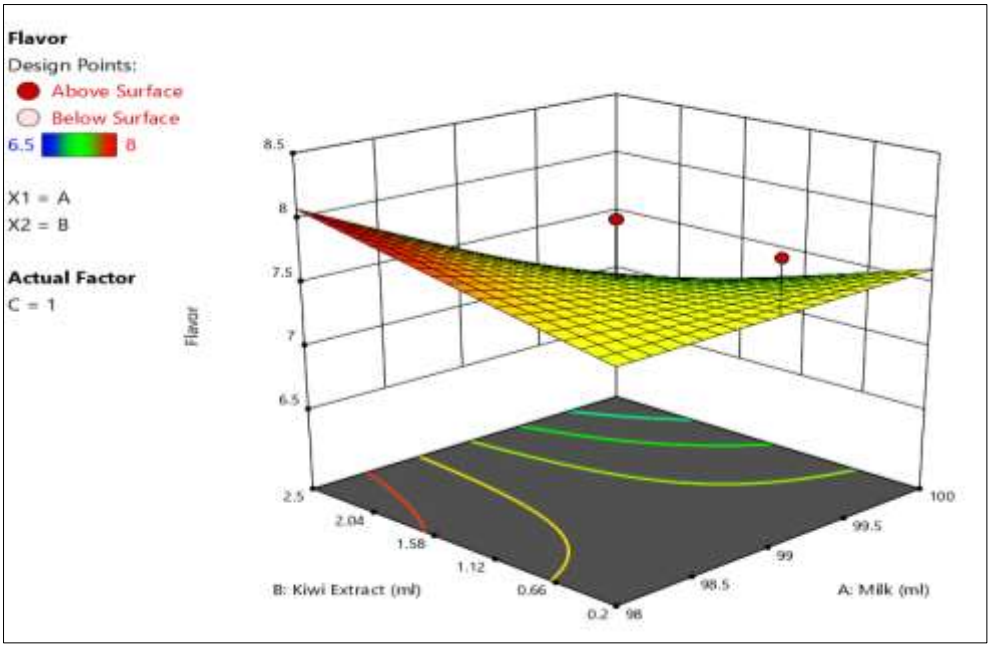

Fig 2: Effect of Kiwi Extract and Milk on flavour of Functional Yoghurt

4.2 Texture

According to data textural properties of functional yoghurt is highly affected by after mixing with kiwi fruit extract in comparison to milk content Fig. 3. According to organoleptic test of flavour is highest value of T4, T12, T13, is 9.0. The lowest value of flavour T1, T2, T6 & T9 is 7.0. Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497 ml kiwi extract, 1.35gm baking powder rest of all 20sample. According to the statistical analysis significant value (p>0.002) and standard deviation (σ=0.020), R^2 is 0.90. According to Świąder, K., Florowska, A., Konisiewicz, Z., & Chen, Y. P. (2020) [24] are found in this research of Tea-Infused Set Yoghurt in textural properties in similar affect as a kiwi fruit extract. The similar data are found Nejad, J. H., Sani, A. M., &Hojjatoleslamy, M. (2014) [9].

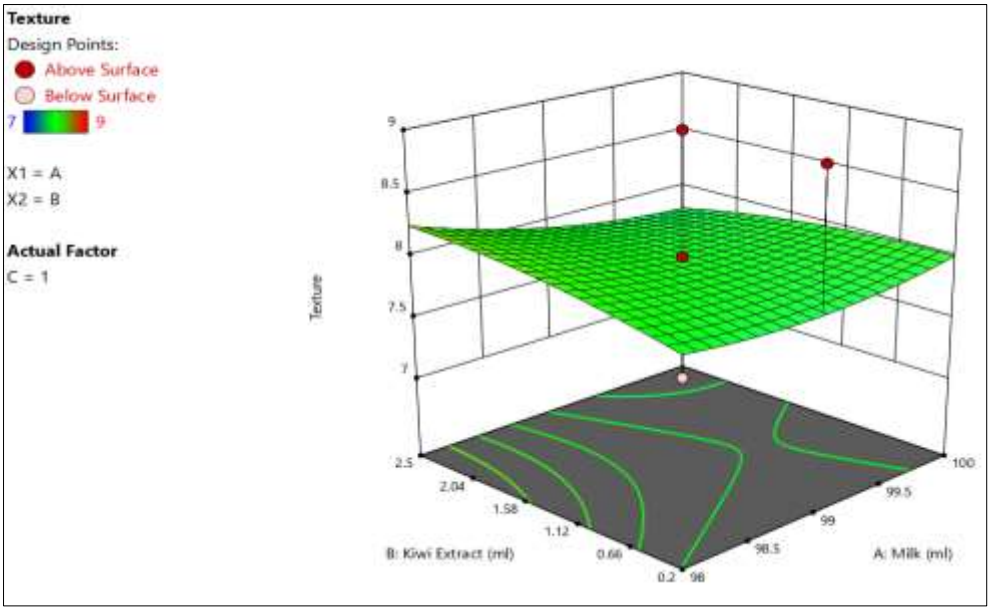

Fig 3: Effect of Kiwi Extract and Milk on Texture of Functional Yoghurt

4.3 Colour

According to data color properties of functional yoghurt is highly affected by after mixing with kiwi fruit extract in comparison to milk content Fig. 4 According to organoleptic test of flavour is highest value of T5, T11, T16, is 9.0. The lowest value of flavour T2, T4 T8, T9 & T16, is 7.0. Table 3.The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20sample. According to the statistical analysis significant value (p>0.004) and standard deviation (σ=0.022), R^2 is 0.79. The white colour is generated by casein with the absence of carotene, while the slight yellowness in colour is generated by the fat granules in milk (Khoiriyah and Fatchiyah, 2013) [12] The similar data are found Nejad, J. H., Sani, A. M., &Hojjatoleslamy, M. (2014) [9]. in which own research in functional Yoghurt of color 9.0 during organoleptic test. According to Matter, A., Mahmoud, A. M., & Zidan, N. S. (2016) [18] are found in papaya flavoured yoghurt in color content is 8.0 by found by organoleptic test. The Baria, B., Singh, A. K., Panjagari, N. R., Arora, S., &Minz, P. S. (2021) [3]. are foundinblack carrot anthocyanins in yoghurt in color properties stability is similar.

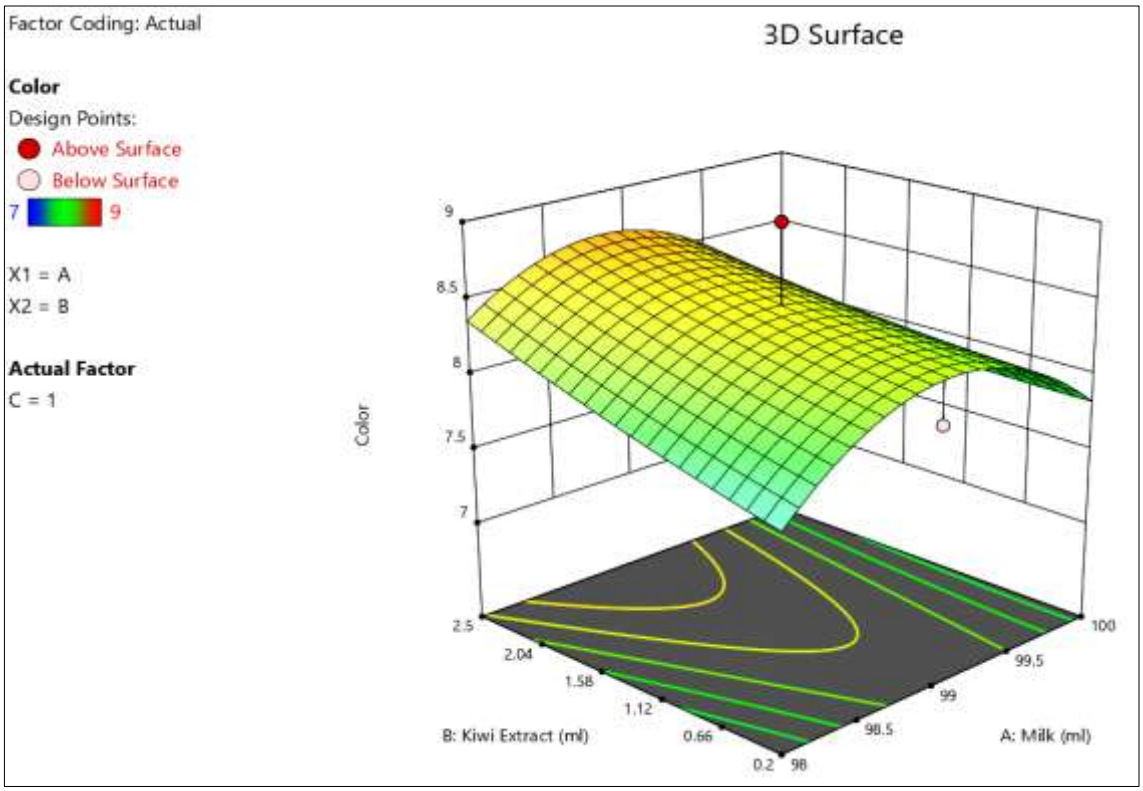

Fig 4: Effect of Kiwi Extract and Milk on Colour of Functional Yoghurt

4.4 Overall acceptability

According to data Overall acceptability properties of functional yoghurt is highly affected by after mixing with kiwi fruit extract in comparison to milk content Fig. 5. According to organoleptic test of flavour is highest value of T4, T9, T10 & T14, is 9.0. The lowest value of flavour T1, T6, T7 & T16, T20 is 7.0. Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20sample. According to the statistical analysis significant value (p>0.005) and standard deviation (σ=0.022), R^2 is 0.88. The overall acceptability rate is found as a similar result found Arkan, N. D., Setyawardani, T., & Rahardjo, A. H. D. (2022) [1]. Thefound nutritional information did not affect the acceptability of 30 these products although analysis of individual consumer behavior showed that only for 31 around 50% of consumers surveyed, also similar results own research Arkan, N. D., Setyawardani, T., &Rahardjo, A. H. D. (2022) [1] and Bayarri, S., Carbonell, I., Barrios, E. X., &Costell, E. (2011) [33]. are also find similar results.

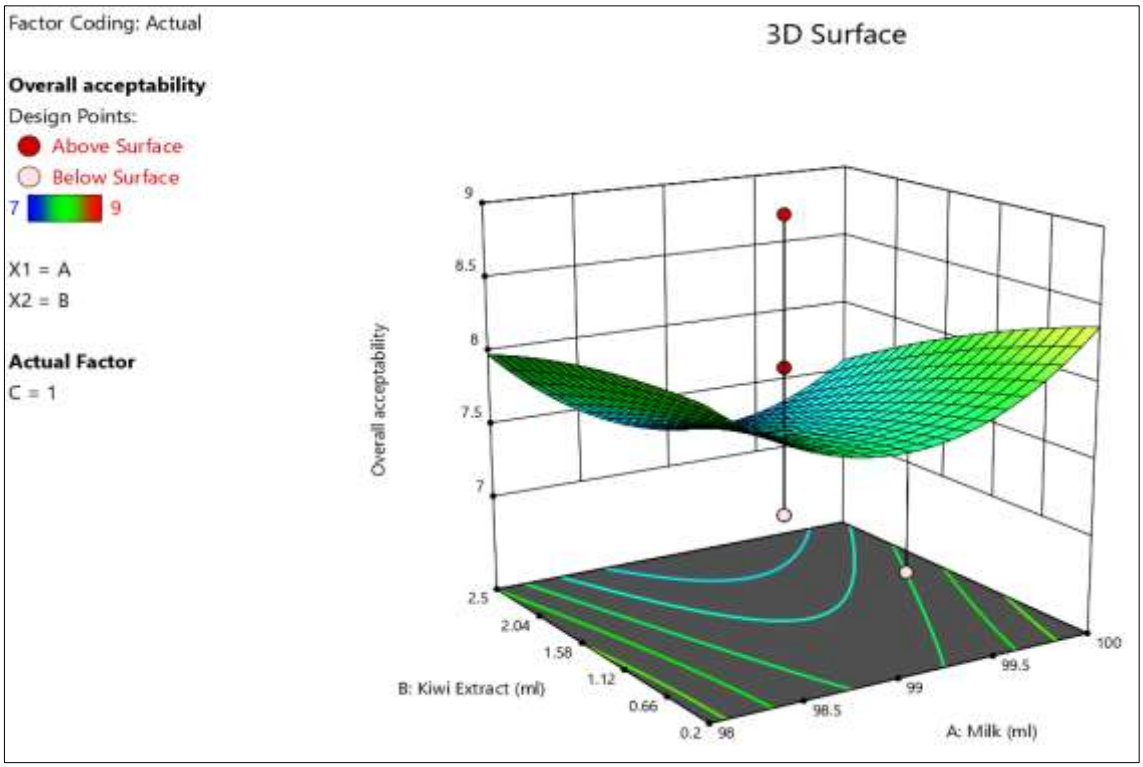

Fig 5: Effect of Kiwi Extract and Milk on Overall acceptability of Functional Yoghurt

4.5 Titratable acidity

According to data Titratable acidity properties of functional yoghurt is highly affected by after mixing with kiwi fruit extract in comparison to milk content Fig. 6. The titratable acidity measure by titration method we found the highest value of T10 is 0.9. The lowest value of flavour T14 & T15 is 0.86. Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20sample. According to the statistical analysis significant value (p>0.004) and standard deviation (σ=0.023), R^2 is 0.87. The evaluation of titrable acidity (0.69-1.81) in Yoghurt Matela, K. S., Pillai, M. K., &Thamae, T. (2019) [17]. According to Tomovska, J., Gjorgievski, N., &Makarijoski, B. (2016) [27]. Find out titratable acidity an increase with decreasing pH value. This is the similar results are found also. Titratable acidity of yoghurt was 0.51 to 0.61 Melia, S., Juliyarsi, I., Kurnia, Y. F., Pratama, Y. E., &Azahra, H. (2022) [19].

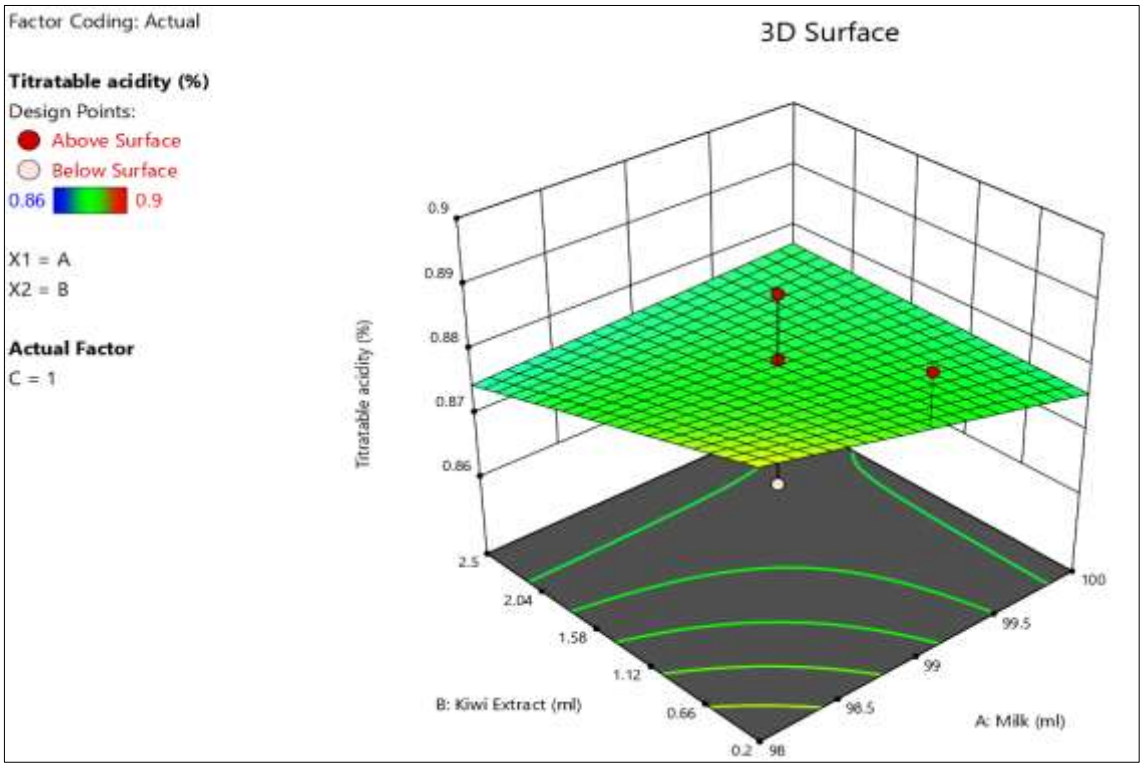

Fig 6: Effect of Kiwi Extract and Milk on Titratable acidity of Functional Yoghurt

4.6 Syneresis

According to data syneresis properties of functional yoghurt is highly affected by after mixing with kiwi fruit extract in comparison to milk content Fig. 7. The value of sysnersis determined by centrifugal method that is highest value of T15, T11 is 40.5. The lowest value of flavour T1, T2, T4, T7, T19 &T20 is 25.5 Table 3. The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20sample. According to the statistical analysis significant value (p>0.005) and standard deviation (σ=0.023), R^2 is 0.87. The similar results found The highest mean value (46.06mL/100 g) of syneresis was recorded in sample of Yogurt enriched with 4 percent kiwi flavor was more acceptable than the other samples, and high scored with respect to overall acceptability by panelists. Hayaty Nejad, J., MohamadiSani, A., &Hojjatoleslamy, M. (2014) [9]. According to Saleena, L. A. K., Chandran, D., Rayirath, G., Shanavas, A., Rajalingam, S., Vishvanathan, M., Sharun, K., &Dhama, K. (2022) [21] are found syneresis is 23.35 percent in Low-calorie Functional Yoghurt. Boukria, O., El Hadrami, E. M., Sameen, A., Sahar, A., Khan, S., Safarov, J., &Aït-Kaddour, A. (2020) [5].

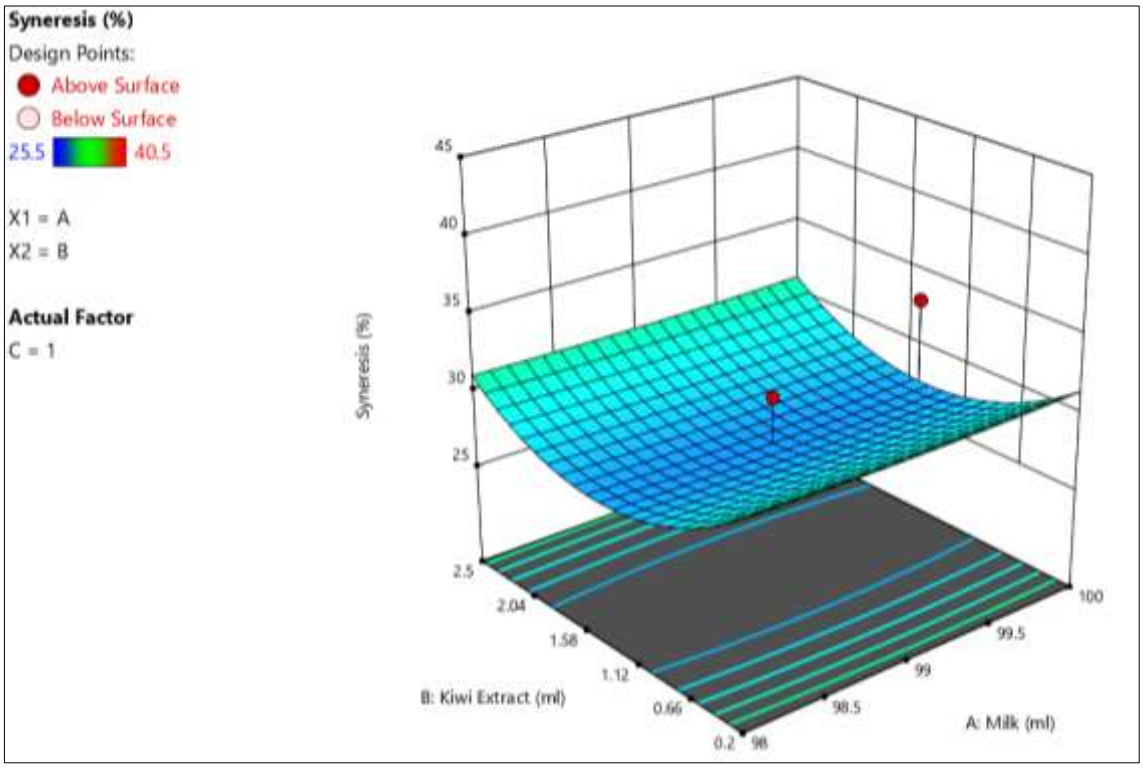

Fig 7: Effect of Kiwi Extract and Milk on Syneresis of Functional Yoghurt

4.7 Viscosity

According to data Viscosity properties of functional yoghurt is highly affected by milk in comparison to kiwi fruit extract content Fig. 8. According to viscometer reading of viscosity is highest value of T8, T15 is 3.50. The lowest value of viscosity T1, & T17 is 1.80. Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20sample. According to the statistical analysis significant value (p>0.006) and standard deviation (σ=0.024), R^2 is 0.90. According to Saleena, L. A. K., Chandran, D., Rayirath, G., Shanavas, A., Rajalingam, S., Vishvanathan, M., Sharun, K., &Dhama, K. (2022) [21] are found syneresis is 23.35 percent in Low-calorie Functional Yoghurt. Boukria, O., El Hadrami, E. M., Sameen, A., Sahar, A., Khan, S., Safarov, J., &Aït-Kaddour, A. (2020) [5]. The research in found during the mixing or loading steps there are structural changes in yogurt, which affect the flow properties Lee, W. J., & Lucey, J. A. (2010) [13].

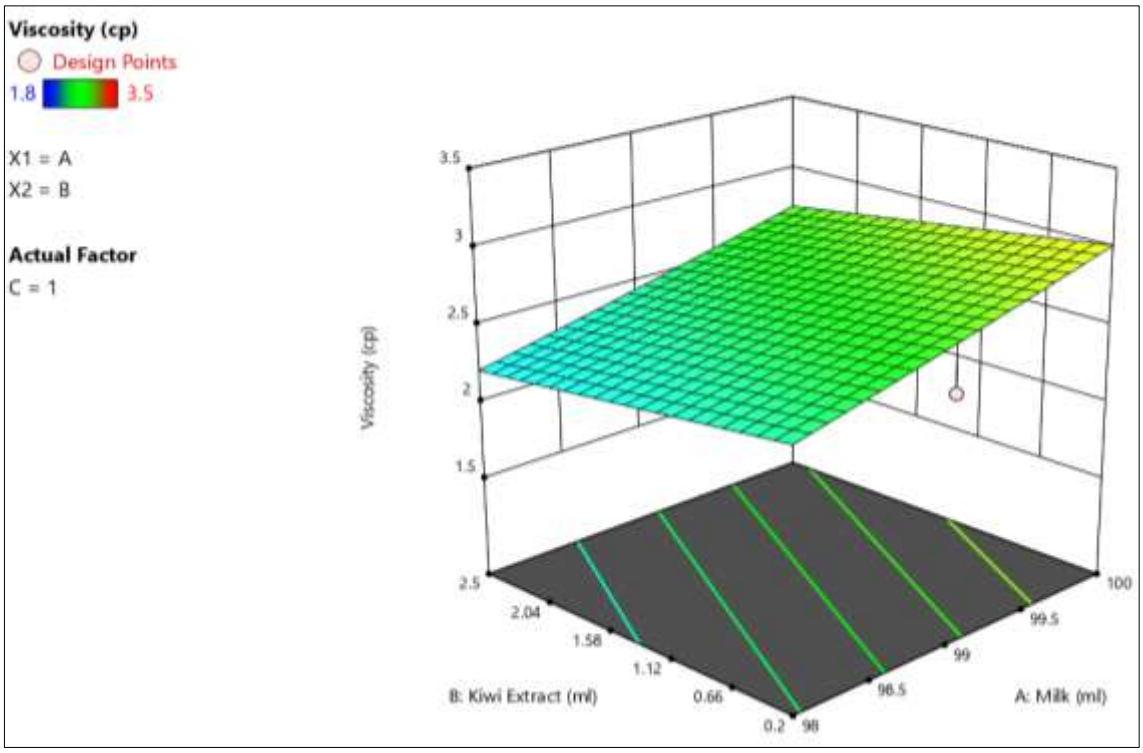

Fig 8: Effect of Kiwi Extract and Milk on Viscosity of Functional Yoghurt

4.8 Curd Tension

According to data Curd Tension properties of functional yoghurt is highly affected by after mixing with kiwi fruit extract in comparison to milk content Fig.9. According to curd tension test of Curd Tension is highest value of T4 is 27.12. The lowest value of flavour T19 is 23.0. Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20sample. According to the statistical analysis significant value (p>0.005) and standard deviation (σ=0.022), R^2 is 0.90. The Malai, S. P., & Geevarghese, P. I. (1998) [19] are find out in which research study the curd tension and viscosity decreased with higher level of replacement but this property improved to certain extent by addition of kiwifruit. El-Sayed, E., Abd El-Gawad, I., Murad, H., & Salah, S. (2002) [8]. The similar results reveal that the use of xanthan gum or its mixtures at mentioned concentration rates markedly increased the curd tension of yogurt as compared to the control when fresh and during storage.

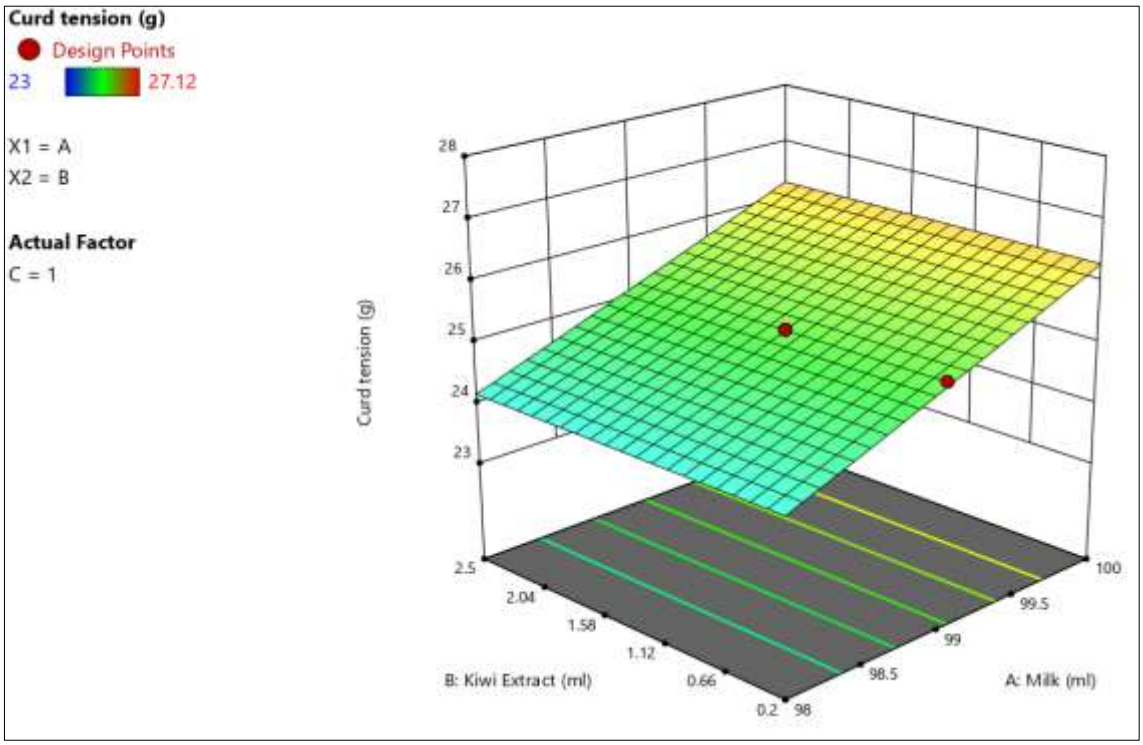

Fig 9: Effect of Kiwi Extract and Milk on Curd Tension of Functional Yoghurt

4.9 Moisture

According to data moisture properties of functional yoghurt is highly affected by after mixing with kiwi fruit extract in comparison to milk content Fig. 10 . the moisture content measure by muffle furnace we have to find out the highest moisture value of T16 is 84.20 The lowest value of moisture T13 is 82.0 Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20sample. According to the statistical analysis significant value (p>0.004) and standard deviation (σ=0.022), R^2 is 0.92. According to Tomovska, J., Gjorgievski, N., & Makarijoski, B. (2016) [27]. Find out moistrue an increase with addition of kiwi fruit extract. This is the similar results are found also. miosture of yoghurt was 81.0 to 85.0 Melia, S., Juliyarsi, I., Kurnia, Y. F., Pratama, Y. E., &Azahra, H. (2022) [19].

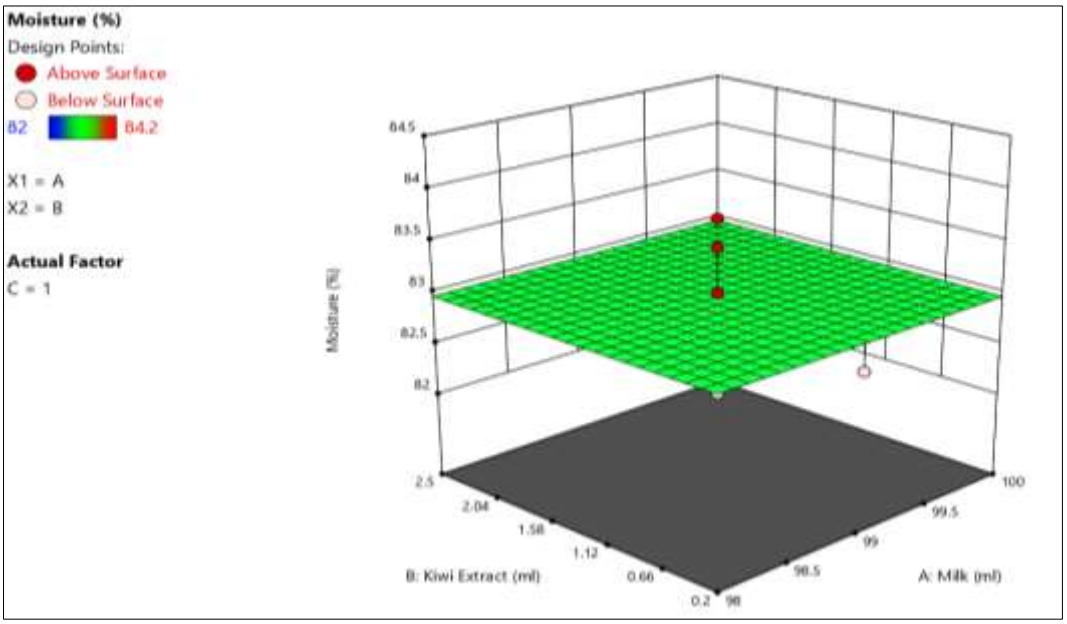

Fig 10: Effect of Kiwi Extract and Milk on Moisture of Functional Yoghurt

4.10 Fat

According to data fat properties of functional yoghurt is slightly affected by after mixing with kiwi fruit extract in comparison to milk content Fig. 11. The fat estimation by Butyrometer we have found of fat is highest value of T14 is 4.20% The lowest value of fat T3 is 3.30% Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20 sample. According to the statistical analysis significant value (p>0.005) and standard deviation (σ=0.032), R^2 is 0.92. The similar results are found Auty, M. A. E., M. Twomey, T. P. Guinee and D. M. Mulvihill. (2001) [2] Kaur, R., Kaur, G., Mishra, S. K., Panwar, H., Mishra, K. K., & Brar, G. S. (2017) [10] are found similar results in which own research study.

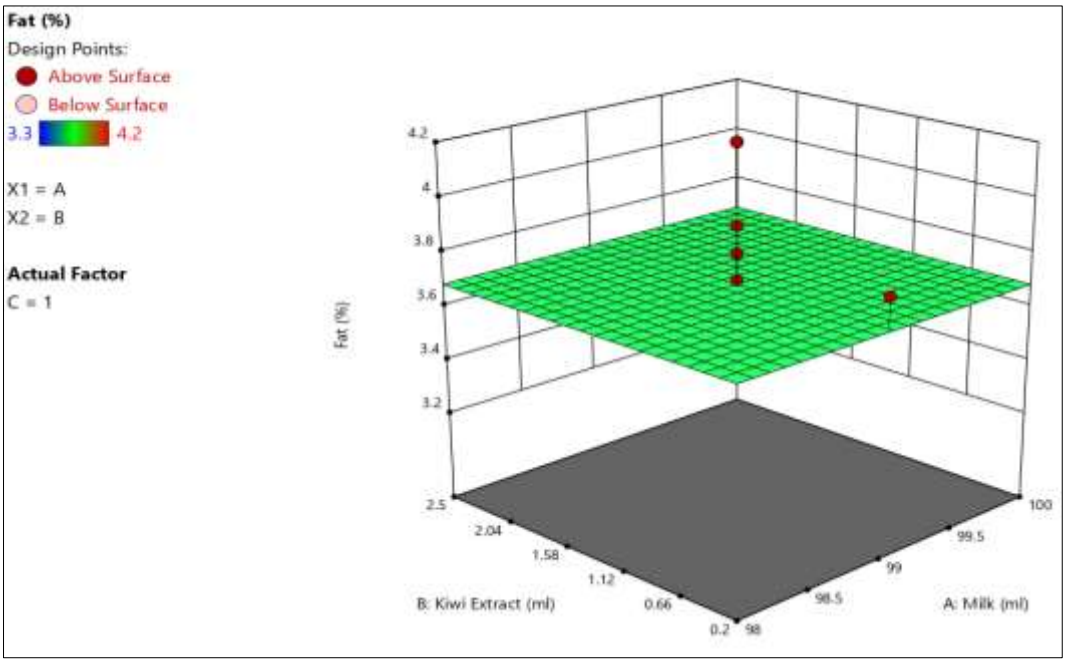

Fig 11: Effect of Kiwi Extract and Milk on Fat of Functional Yoghurt

4.11 Protein

According to data fat properties of functional yoghurt is no any changes in protein content and protein properties after mixing with kiwi fruit extract in comparison to milk content Fig. 12. The protein estimation by kjeldahl method we have found of protein is highest value of T7 & T17 is 4.90% The lowest value of protein T19 is 4.23% Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20 sample. According to the statistical analysis significant value (p>0.005) and standard deviation (σ=0.032), R^2 is 0.92. Similar results found of Delikanli B, Ozcan T. (2014) [7] and Sandoval-Castilla O, Calleros CL, Aguirre EM, Vernon CEJ. (2004) [27].

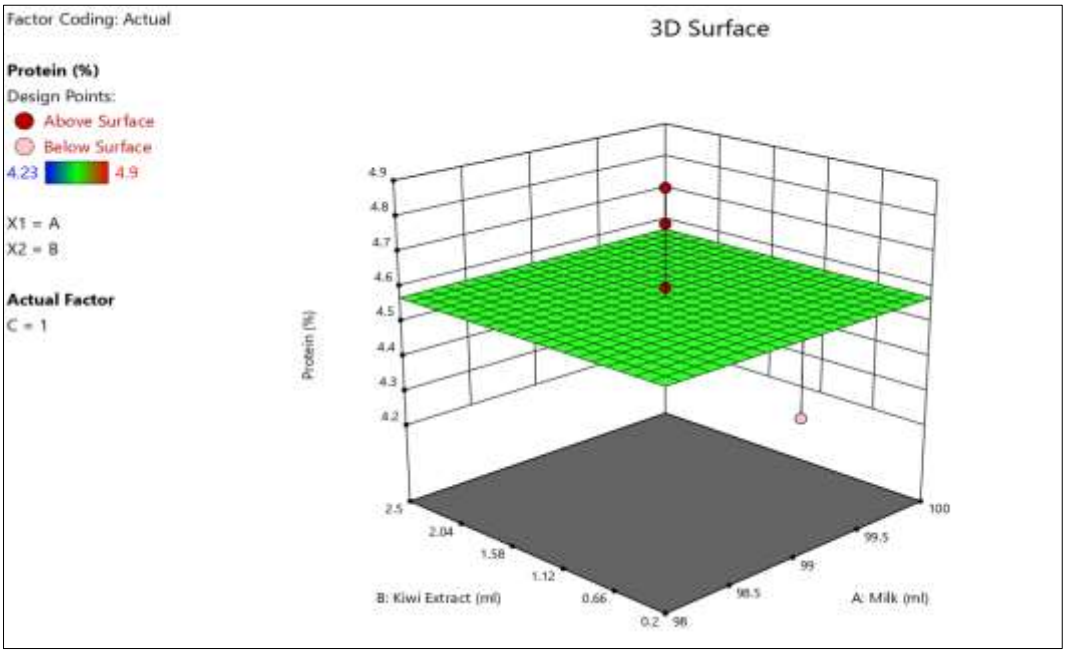

Fig 12: Effect of Kiwi Extract and Milk on Protein of Functional Yoghurt

4.12 Total Solid

According to data total solid content of functional yoghurt is no any type changes after mixing kiwi fruit extract with milk content Fig. 13. The total solid is highest value of T4 & T15 is 18.0% The lowest value of total solid T4 is 14.50% Table 3 The best optimized sample of functional yoghurt in 99% milk, 0.497ml kiwi extract, 1.35gm baking powder rest of all 20 sample. According to the statistical analysis significant value (p>0.005) and standard deviation (σ=0.032), R^2 is 0.92. Kaur, R., Kaur, G., Mishra, S. K., Panwar, H., Mishra, K. K., & Brar, G. S. (2017) [11] are found similar results in which own research study.

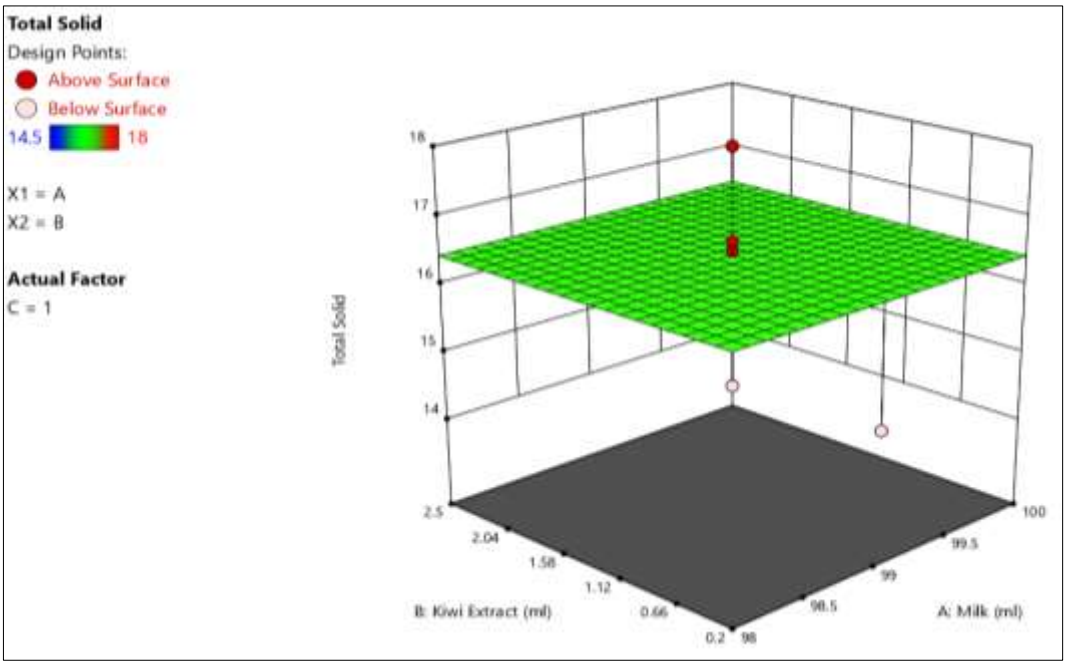

Fig 13: Effect of Kiwi Extract and Milk on Total Solid of Functional Yoghurt

Table 3: Central composite rotatable design for the optimization of the of kiwi extract Yoghurt

Treatment	Milk	Kiwi extract	Flavor	Texture	Color	Overall acceptability	Syneresis	Viscosity	Curd tension	Fat	Protein	Total Solid
T1	99	1.35	8	7	8	7	25.5	1.8	25.23	3.6	4.3	16.55
T2	99	1.35	7	7	7	8	25.5	2	25.24	3.8	4.5	17.66
T3	98	2.5	8	8	8	8	35.35	1.9	24.3	3.3	4.7	17.55
T4	100	1.35	6	9	7	9	25.5	3	27.12	3.5	4.8	15.5
T5	99	1.35	8	8	9	8	30.33	2.5	25.23	3.4	4.6	14.5
T6	100	2.5	7	7	7	7	35.35	3	26.21	3.6	4.3	15.9
T7	99	1.35	9	8	8	7	25.5	2.5	25.23	3.4	4.5	18
T8	98	0.2	6	8	7	8	30.33	3.5	24.3	3.5	4.9	16.65
T9	100	0.2	8	7	7	9	30.33	2.7	26.21	3.6	4.8	17.5
T10	98	0.2	8	7	8	9	30.33	3.4	24.33	3.7	4.7	16.45
T11	99	3.28	7	8	9	7	30.33	3	25.23	3.7	4.4	14.87
T12	99	0.23	9	9	8	7	40.5	2.4	25.23	3.8	4.35	14.58
T13	99	1.35	8	9	8	8	25.5	2.5	25.23	3.9	4.78	15.88
T14	99	1.35	7	8	9	9	25.5	2.5	25.23	4.2	4.88	16.65
T15	100	2.5	7	7	8	8	35.35	3.5	26.21	3.8	4.65	18
T16	99	1.35	9	7	9	7	25.5	2.5	25.23	3.7	4.45	16.5
T17	98	2.5	8	8	8	8	35.35	1.8	24.3	3.8	4.9	15.5
T18	100	0.2	7	7	8	8	30.33	3	26.21	3.9	4.32	16.65
T19	97.31	1.35	8	8	7	9	25.5	1.9	23	3.7	4.23	17.88
T20	99	1.35	8	7	8	7	25.5	2.5	25.23	3.8	4.38	15.9

Table 4: Central composite rotatable design for the optimization of the of kiwi extract yoghurt

Replication	Milk	Kiwi extract	Baking Powder	Flavor	Texture	Color	Overall acceptability	Syneresis	Curd tension	Fat	Protein
R1	99	0.497	1.353	7.824	7.7	7.89	7.842	29.67	25.194	3.68	4.57
R2	99	0.497	1.353	7.8	7.6	7.8	7.80	29.50	25.07	3.54	4.23
R3	99	0.497	1.353	7.79	7.7	7.87	7.82	29.0	24.98	3.24	4.86
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5. Conclusion

This study observed that the enriched kiwifruit yoghurt produced to be nutritionally and sensorially superior in most quality attributes than the conventional yoghurt. Probiotic functional yoghurt may be a potential alternative to cater the expanding market of functional foods. Yoghurt is very popular for its healthy picture and can be suitably utilized as a probiotic carrier. Functional properties of normal yoghurt can be enhanced with the inclusion of probiotics, but yoghurt environment may not be favorable for all probiotic culture; therefore, bioactivity of probiotic cultures in yoghurt matrix must be evaluated before its commercial application. Inclusion of probiotic cultures in yoghurt is suggested to extend the functional properties of normal yoghurt and may emerge as most common healthy functional dairy product. Yoghurt is a good fermented dairy product. It has functional and healthy effects as the vital force of the final product survived at the level of probiotic functional product count (10^6 cfu/g) which extends the shelf- life of the yoghurt. Additionally, kiwi fruit milk yoghurt had acceptable results in sensory properties (taste and smell), because probiotic bacteria masked the bean flavor of kiwi fruit in the final product. Thus functional Yoghurt with antioxidant properties which would be acceptable. On the other hand, kiwi fruit yoghurt had the highest content of vitamin c and unsaturated fatty acids making it a healthier food product.

6. References

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