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DEVELOPMENT OF INSTANT FOOD PRODUCTS FROM POTATO STARCH

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ABSTRACT

This study focuses on the standardisation of recipes for the preparation of instant food products from potato starch. The objectives were to standardise instant food recipes using these starches and to evaluate the effects of storage on the quality of these instant products. Fresh potatoes were characterised by an average fruit length of 5.48 cm, width of 3.88 cm, volume of 46.66 cm³, and weight of 49.40 g, with a pH of 7.33. Chemical analyses revealed a titratable acidity of 0.52% citric acid, ascorbic acid content of 1.86 mg/100g, and total phenols of 0.92 mg/100g. Instant potato custard mix exhibited a total soluble solids (TSS) of 35.23 ºB, pH of 5.8, moisture content of 3.8%, and ash content of 2.2%. Its protein content was 2.9 g, with a titratable acidity of 0.98% citric acid, reducing sugars of 11.47%, total sugars of 31.17%, ascorbic acid of 4.1 mg/100g, and total phenols of 1.58 mg/100g. Instant potato halwa mix showed a TSS of 39 ºB, pH of 6.6, moisture content of 4.7%, and ash content of 3.5%. It contained 3.9 g protein, 0.35% citric acid, reducing sugars of 17.61%, total sugars of 37.77%, ascorbic acid of 3.13 mg/100g, and total phenols of 1.81 mg/100g. Storage studies indicated that the physicochemical properties of both instant products changed over six months, with increases in pH and moisture content and decreases in titratable acidity, ascorbic acid, reducing sugars, total sugars, total phenols, and protein content. The study concludes that T1 starch extraction and T2 custard mix, along with T1 halwa mix, demonstrated the best sensory qualities. Minimal changes in quality characteristics were observed, suggesting that these standardised methods and products offer potential for future development of nutritious instant food products.

Keywords: Instant products, phenols, potato starch, reducing sugars, starch extraction, titratable acidity.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important food crops globally, ranking among the top staple foods due to its high yield potential, affordability, and nutritional value.

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It is a rich source of carbohydrates, primarily in the form of starch, and also contributes dietary fibre, vitamin C, minerals, and various bioactive compounds such as phenolics (Burton, 1989; Camire *et al.*, 2009). Owing to its versatility and wide consumer acceptance, potato has been extensively utilised in both fresh and processed forms across different food systems.

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Potato starch, which constitutes a major portion of the tuber's dry matter, possesses desirable functional properties including high swelling power, viscosity, gel formation, and water-holding capacity. These properties make it particularly suitable for use in instant and convenience food formulations (Singh *et al.*, 2003). With the rapid pace of urbanisation, changes in lifestyle, and increasing participation of women in the workforce, there has been a marked rise in the demand for ready-to-cook and ready-to-eat foods that require minimal preparation time while maintaining acceptable nutritional and sensory quality (Ramaswamy & Marcotte, 2006).

Instant food products prepared from starch-based ingredients must be carefully standardised to ensure consistency in quality, taste, texture, and appearance. The method of starch extraction, formulation ratios, and processing conditions significantly influence the physicochemical characteristics of the final product (Adebowale *et al.*, 2005). Furthermore, the incorporation of starch into traditional food preparations such as custard and halwa offers an opportunity to develop value-added products that combine convenience with cultural familiarity and consumer appeal.

Storage stability is a critical aspect in the development of instant food mixes. During storage, changes may occur in moisture content, pH, sugars, organic acids, vitamins, proteins, and phenolic compounds due to chemical reactions, oxidation, and interactions among food components (Fellows, 2017). Ascorbic acid and phenolic compounds, in particular, are sensitive to storage conditions and serve as important indicators of nutritional quality deterioration over time (Davey *et al.*, 2000). Therefore, evaluating the effect of storage on physicochemical and sensory attributes is essential to determine the shelf life and market potential of instant products.

In view of these considerations, the present study was undertaken to standardise recipes for instant food products using potato starch and to assess their quality characteristics. The study further aimed to evaluate the effect of storage on the physicochemical, nutritional, and sensory properties of instant potato custard mix and halwa mix. By identifying suitable starch extraction methods and formulations with minimal quality deterioration during storage, the research seeks to explore the potential of potato starch-based instant products as nutritious, shelf-stable convenience foods for future development and commercialisation.

MATERIAL AND METHODS

The present investigation entitled 'Development of Instant Food Products from Potato Starch' was conducted under different experiments in the Department of Food Science and Technology, V.C.S.G. College of Horticulture, Bharsar (Pauri Garhwal), during the years 2014–

2015 and 2015–2016. The materials used, experimental details, and techniques employed are described in this section.

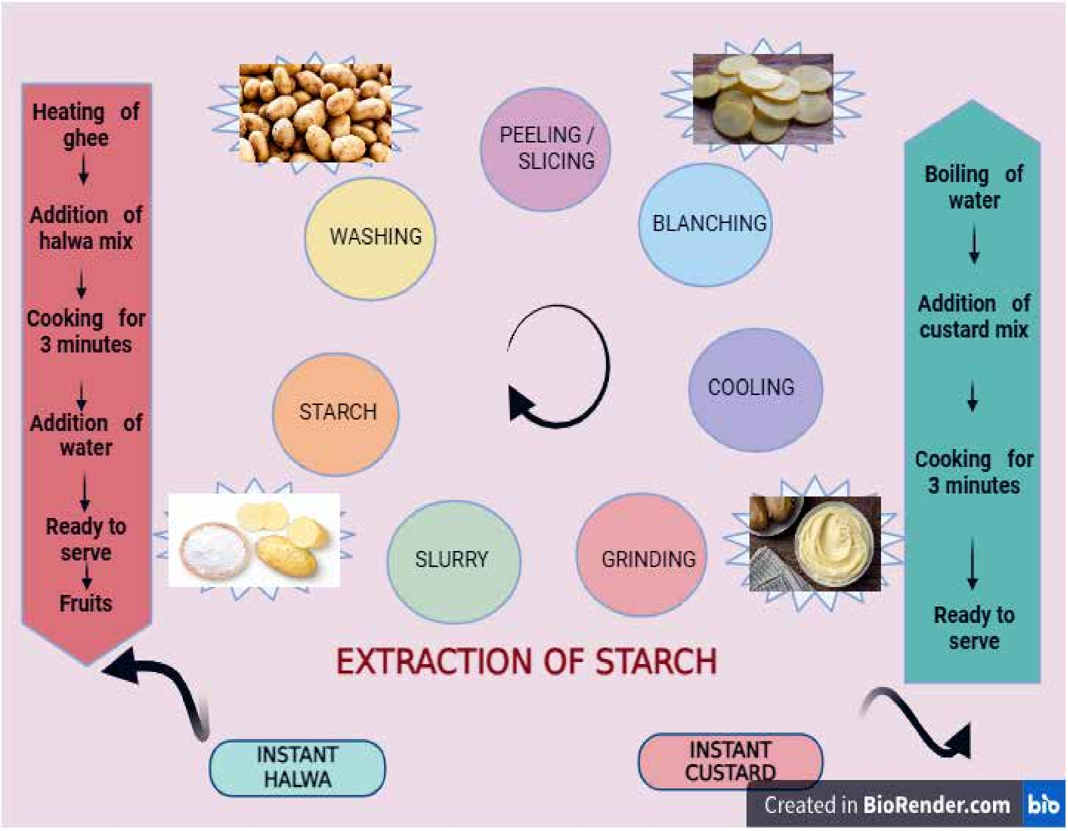

Figure1: Process of Extraction of Starch

Raw Materials

Potatoes were procured from the Department of Vegetable Sciences, V.C.S.G. College of Horticulture, Bharsar, Pauri Garhwal. Milk powder, table sugar, turmeric powder, potato starch, potato flour, and vanilla essence were purchased from the local market.

Product Development

Instant Potato Custard Mix : To standardise the instant custard mix, different quantities of ingredients viz. milk powder, potato starch, potato flour, sugar, turmeric powder, and vanilla essence were used, as given in Table 1. The ingredients were mixed and vacuum packed. To evaluate the effect of storage conditions on the quality of the prepared product, two storage systems were employed: refrigerated and ambient conditions. The standardised recipe was then evaluated for various functional properties at regular intervals of two months over a period of six months.

Figure 1 illustrates the process of starch extraction.

Table 1: Ingredient combinations for the preparation of instant potato custard mix

Treatment	Milk Powder (g)	Starch (g)	Flour (g)	Sugar (g)	Turmeric (g)	Vanilla (g)
T1	30	2.00	2.00	10	0.1	3
T2	30	2.25	1.75	10	0.1	3
T3	30	2.50	1.50	10	0.1	3
T4	30	2.75	1.25	10	0.1	3
T5	30	3.00	1.00	10	0.1	3

Source: Authors' compilation from experimental records.

Instant Potato Halwa Mix

To standardise the instant potato halwa mix, measured quantities of ingredients were used as given in Table 2. The best combination was determined after sensory evaluation and was subsequently subjected to vacuum packing and a storage study. The product was evaluated for various functional properties under both ambient and refrigerated conditions. Figure 3 presents the flow sheet for instant halwa preparation.

Table 2: Ingredient combinations for the preparation of instant potato halwa mix

Treatment	Potato Grit (g)	Ghee (g)	Sugar (g)	Fennel (g)	Small Carda-mom (g)
T1	30	10	44	0.6	0.4
T2	40	10	44	0.6	0.4
T3	50	10	44	0.6	0.5

Source: Authors' compilation from experimental records.

Proximate Analysis

Moisture Content : Moisture content was determined using the oven drying method as described by Ranganna (2007). Weighed samples were dried to a constant weight in a hot-air oven at 70 ± 2ºC. The dried samples were cooled to room temperature in a desiccator prior to weighing. Loss in weight after drying was expressed as moisture percentage:

$$Moisture\ (\%) = [(Fresh\ weight - Dry\ weight) / Fresh\ weight] \times 100$$

Ash Content : Ash was estimated by the standard method of analysis (AOAC, 2000). Five grams of oven-dried sample were weighed in a silica crucible and placed in a muffle furnace at 550ºC for 5–6 hours, or until white ash was obtained. The crucible was cooled in a desiccator and weighed.

$$Ash\ (\%) = [(W_3 - W_1) / (W_2 - W_1)] \times 100$$

Where: W_1 = Initial weight of empty crucible; W_2 = Weight of crucible + sample before ashing; W_3 = Weight of crucible + sample after ashing.

Crude Protein : Crude protein was determined using the Kjeldahl method (Ranganna, 1967), in which nitrogen content is estimated based on the conversion of nitrogenous compounds to ammonium sulphate by digestion with concentrated sulphuric acid. The ammonium sulphate is subsequently decomposed with sodium hydroxide and the liberated ammonia is absorbed in excess neutral boric acid and titrated with standard acid. A sample of 0.5 g was digested with 0.5 g digestion mixture (2.5 g SeO_2 + 20 g $CuSO_4 \cdot 5H_2O$ + 100 g K_2SO_4) in 25 mL concentrated H_2SO_4 for five hours or until colourless. The digest was transferred to a 100 mL volumetric flask and made up to volume with distilled water.

$$\text{Crude Protein (\%)} = \text{\% Nitrogen} \times 6.25$$

Crude Fat : Crude fat was determined using the Soxtec oil extraction method (Ranganna, 2007). Twenty grams of sample were extracted in a Soxtec Oil Extraction Apparatus (M/s Velp Scientifica, SRL, Italy) using petroleum ether (bp 40–60ºC) as solvent for six hours. After recovering approximately 90% of the solvent, the remainder was allowed to evaporate in an oven. The extracted oil was quantified and expressed as percentage.

$$\text{Fat (\%)} = (\text{Weight of oil} / \text{Weight of sample}) \times 100$$

Total Carbohydrates : Total carbohydrate content on a dry weight basis was determined by subtracting the percentages of crude protein, crude fat, moisture, and ash content from 100 (Ranganna, 2007):

$$\text{Total Carbohydrates (\%)} = 100 - (\text{\% Crude Protein} + \text{\% Crude Fat} + \text{\% Moisture} + \text{\% Ash})$$

Energy Value : The energy value of products was calculated using the method given by Ranganna (2007):

$$\text{Energy (kcal/100g)} = (\text{Crude Protein} \times 4.1) + (\text{Crude Fat} \times 9.3) + (\text{Carbohydrate} \times 4.1)$$

Sensory Evaluation

Sensory evaluation of the developed instant products was conducted before and during storage on the basis of colour/appearance, flavour/aroma, body, taste, and overall acceptability using a 9-point hedonic scale according to the method of Amerine *et al*. (1965). The taste panel comprised 7–9 faculty members and postgraduate students from the Department of Food Science and Technology, V.C.S.G. College of Horticulture, Bharsar (Pauri Garhwal). Efforts were made to retain the same panel throughout the entire study period. Plain water was provided to panellists for mouth rinsing between evaluations.

Statistical Analysis

Data pertaining to the sensory evaluation of starch and flour-based food products were analysed according to Randomised Complete Block Design as described by Mahoney (1985), while data on chemical characteristics of different products before and during storage were analysed by following Completely Randomised Design (CRD) at the 95% level of significance (Cochran & Cox, 1967).

RESULTS AND DISCUSSION

The present investigation, entitled 'Development of Instant Food Products from Potato Starch', was conducted in the Department of Food Science and Technology, College of

Horticulture, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal. The results obtained are discussed under the following heads.

Moisture Content (%) of Instant Potato Custard Mix

The data on moisture content of the potato custard mix are presented in Table 3. A significantly higher increase in moisture content was recorded with advancing storage duration. The maximum moisture content (5.0%) was recorded under refrigerated conditions at six months, whereas the minimum (4.1%) was recorded at ambient temperature during two months of storage.

Table 3: Effect of storage duration and condition on moisture content (%) of instant potato custard mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	4.1	4.5	4.9	4.5
Refrigerated	4.3	4.7	5.0	4.7
Mean	**4.2**	**4.6**	**4.9**	
$CD_{0.05}$: I = 0.09; S = 0.07; I×S = 0.13				

Source: Experimental data.

Protein Content (g) of Instant Potato Custard Mix

The data on protein content of the potato custard mix are presented in Table 4. A significantly higher decrease in protein content was observed with advancing storage duration. The maximum protein content (2.1 g) was recorded under refrigerated conditions at two months, whereas the minimum (1.0 g) was recorded at ambient temperature during six months of storage.

Table 4: Effect of storage duration and condition on protein (g) content of instant potato custard mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	1.9	1.4	1.0	1.4
Refrigerated	2.1	1.6	1.1	1.6
Mean	**2.0**	**1.5**	**1.0**	
$CD_{0.05}$: I = 0.127; S = 0.104; I×S = NS				

Source: Experimental data.

Sensory Evaluation of Instant Potato Halwa Mix

The data on sensory evaluation of instant potato halwa mix are presented in Table 5. Significant differences were observed among treatments, likely due to amylose and amylopectin recrystallisation (retrogradation) within the starch granules. Treatment T1 recorded the highest scores for colour (8.2), flavour (8.4), texture (8.4), and overall acceptability (8.4). Treatment T2 ranked second across all parameters, while T3 received the lowest scores.

Table 5: Effect of various treatments on sensory parameters of instant potato halwa mix

Treatment	Colour	Flavour	Texture	Overall Acceptability
T1	8.2	8.4	8.4	8.4
T2	7.4	6.8	7.4	7.2
T3	7.0	5.4	6.6	5.8
Mean	**7.5**	**6.8**	**7.4**	**7.1**
$CD_{0.05}$	0.99	0.92	0.84	0.75

Source: Experimental data.

Functional Properties of Standardised Instant Potato Halwa Mix

Table 6: Functional properties of standardised instant potato halwa mix

Parameter	Mean ± S.D.
Physical Parameters	
TSS (ºB)	39.00 ± 0.05
pH	6.60 ± 0.005
Moisture (%)	4.70 ± 0.01
Ash (%)	3.50 ± 0.10
Biochemical Parameters	
Protein (g)	3.90 ± 0.15
Titratable Acidity (% citric acid)	0.29 ± 0.01
Reducing Sugars (%)	17.61 ± 0.25
Total Sugars (%)	37.77 ± 0.23
Antioxidant Parameters	
Total Phenols (mg/100g)	1.81 ± 0.01
Ascorbic Acid (mg/100g)	3.13 ± 0.06

Source: Experimental data.

Physical Parameters : The instant potato halwa mix contained TSS of 39.00 ± 0.05 ºB, pH of 6.60 ± 0.05, moisture of 4.70 ± 0.01%, and ash of 3.50 ± 0.10%.

Biochemical Parameters : The biochemical characteristics of the standardised instant halwa mix showed a protein content of 3.90 ± 0.15 g, titratable acidity of 0.35 ± 0.01% as citric acid, reducing sugars of 17.61 ± 0.25%, and total sugars of 37.77 ± 0.23%.

Antioxidant Parameters : Ascorbic acid content of the instant potato halwa mix was observed to be 3.13 ± 0.06 mg/100g, while total phenols were recorded at 1.81 ± 0.01 mg/100g, reflecting the antioxidant potential of the product.

Effect of Storage on Instant Potato Halwa Mix

Total Soluble Solids (ºB) : The data on TSS of the instant potato halwa mix during storage are presented in Table 7. The maximum TSS (39.4 ºB) was obtained under refrigerated storage conditions, while the minimum TSS (37.5 ºB) was recorded under ambient conditions at six months. A progressive decrease in TSS was observed with advancement of storage period.

Table 7: Effect of storage duration and condition on TSS (ºB) of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	38.8	38.1	37.5	38.1
Refrigerated	39.4	38.4	37.7	38.5
Mean	**39.1**	**38.2**	**37.6**	
$CD_{0.05}$: I = 0.135; S = 0.110; I×S = 0.191				

Source: Experimental data.

Titratable Acidity (%) : The data in Table 8 show a decreasing trend in titratable acidity during storage. The maximum titratable acidity (0.26%) was recorded at two months under refrigerated storage conditions, whereas the minimum (0.20%) was recorded at six months under ambient conditions.

Table 8: Effect of storage duration and condition on titratable acidity (%) of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	0.22	0.21	0.20	0.21
Refrigerated	0.26	0.25	0.24	0.25
Mean	**0.24**	**0.23**	**0.22**	
$CD_{0.05}$: I = 0.002; S = 0.002; I×S = 0.003				

Source: Experimental data.

Ascorbic Acid (mg/100g) : The data presented in Table 9 show a significant decrease in ascorbic acid during storage. The maximum ascorbic acid content (2.71 mg/100g) was observed at two months under refrigerated conditions. The minimum (2.52 mg/100g) was recorded at six months under ambient conditions.

Table 9: Effect of storage duration and condition on ascorbic acid (mg/100g) of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	2.68	2.58	2.52	2.59
Refrigerated	2.71	2.65	2.55	2.63
Mean	**2.69**	**2.61**	**2.53**	
$CD_{0.05}$: I = 0.115; S = 0.012; I×S = 0.021				

Source: Experimental data.

pH : Changes in pH during storage intervals and conditions are presented in Table 10. pH increased progressively under both storage conditions. The minimum pH value (6.8) was recorded at two months under ambient conditions, while the maximum (7.3) was found at six months under refrigerated conditions.

Table 10: Effect of storage duration and condition on pH of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	6.8	7.0	7.1	6.9
Refrigerated	6.9	7.2	7.3	7.1
Mean	**6.8**	**7.1**	**7.2**	
$CD_{0.05}$: I = 0.094; S = 0.077; I×S = 0.133				

Source: Experimental data.

Total Sugars (%) : The effect of storage intervals and conditions on total sugars is shown in Table 11. The maximum total sugars (35.52%) were observed at two months under refrigerated storage conditions, whereas the minimum (33.35%) was observed at six months under ambient conditions.

Table 11: Effect of storage duration and condition on total sugars (%) of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	35.15	34.09	33.35	34.19
Refrigerated	35.52	35.11	34.34	34.99
Mean	**35.33**	**34.60**	**33.84**	
$CD_{0.05}$: I = 0.019; S = 0.015; I×S = 0.026				

Source: Experimental data.

Reducing Sugars (%) : The data in Table 12 show the effect of storage duration and conditions on reducing sugars. The maximum reducing sugar content (16.26%) was recorded at two months under refrigerated conditions. The minimum (13.50%) was recorded at six months under ambient conditions. Overall, the decline in reducing sugars was greater under ambient conditions than under refrigerated conditions with advancing storage.

Table 12: Effect of storage duration and condition on reducing sugars (%) of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	15.15	14.21	13.50	14.28
Refrigerated	16.26	14.32	14.10	14.89
Mean	**15.70**	**14.26**	**13.80**	
$CD_{0.05}$: I = 0.073; S = 0.060; I×S = 0.104				

Source: Experimental data.

Total Phenols (mg/100g) : The data in Table 13 show a significant decrease in total phenols during storage, likely attributable to oxidative polymerisation or interaction with the protein matrix at a molecular level. The maximum total phenols (1.79 mg/100g) were observed at two months under refrigerated conditions, while the minimum (1.72 mg/100g) was recorded at six months under ambient conditions.

Table 13: Effect of storage duration and condition on total phenols (mg/100g) of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	1.77	1.75	1.72	1.74
Refrigerated	1.79	1.78	1.74	1.77
Mean	**1.78**	**1.76**	**1.73**	
$CD_{0.05}$: I = 0.017; S = 0.014; I×S = 0.024				

Source: Experimental data.

Moisture Content (%) of Instant Potato Halwa Mix : The data on moisture content of the instant potato halwa mix are presented in Table 14. Significant differences were observed across storage intervals. The maximum moisture content (6.6%) was recorded at six months under refrigerated conditions, while the minimum (5.0%) was observed at two months under ambient conditions. The interaction between storage interval and condition was found to be statistically significant.

Table 14: Effect of storage duration and condition on moisture content (%) of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	5.0	5.6	6.3	5.6
Refrigerated	5.3	6.0	6.6	5.9
Mean	**5.1**	**5.8**	**6.4**	
$CD_{0.05}$: I = 0.095; S = 0.077; I×S = 0.134				

Source: Experimental data.

Protein Content (g) of Instant Potato Halwa Mix : The data on protein content during different storage conditions and intervals are presented in Table 15. The maximum protein content (3.3 g) was recorded at two months under refrigerated conditions, while the minimum (1.5 g) was recorded at six months under ambient conditions. The interaction between storage interval and condition was found to be non-significant.

Table 15: Effect of storage duration and condition on protein (g) content of instant potato halwa mix

Storage Conditions (S)	2 Months	4 Months	6 Months	Mean
Ambient	3.1	2.1	1.5	2.2
Refrigerated	3.3	2.4	1.8	2.5
Mean	**3.2**	**2.2**	**1.6**	
$CD_{0.05}$: I = 0.124; S = 0.101; I×S = NS				

Source: Experimental data.

Physicochemical Analysis of Instant Halwa Mix and Custard Mix

Table 16: Physicochemical analysis of instant potato halwa mix

S.No.	Characteristic	Quantity
1	Crude Protein (N × 6.25) %	3.9
2	Fat (%)	6.4
3	Carbohydrate (%)	90.0
4	Moisture (%)	4.7
5	Ash (%)	3.5
6	Total Sugars (%)	37.77
7	Energy (kcal/100g)	421

Source: Experimental data.

Table 17: Physicochemical analysis of instant potato custard mix

S.No.	Characteristic	Quantity
1	Crude Protein (N × 6.25) %	2.9
2	Fat (%)	4.0
3	Carbohydrate (%)	86.2
4	Moisture (%)	3.8
5	Ash (%)	2.2
6	Total Sugars (%)	31.17
7	Energy (kcal/100g)	428

Source: Experimental data.

CONCLUSION

The investigation into the development of instant food products from potato starch has yielded comprehensive insights into optimising both the development process and the quality of instant potato products. The study effectively standardised methodologies for the preparation of instant food products from potato starch, underscoring the method's efficiency and its potential for broader application in both Industrial and small-scale settings.

In terms of product development, the research demonstrated that T2 was the most effective formulation for producing instant potato custard, while T1 was found to be superior for instant potato halwa mix based on sensory evaluations. This distinction highlights the potential for tailored approaches in creating diverse instant potato products that meet specific consumer preferences and quality standards.

Both instant potato custard and halwa mixes exhibited minimal changes in quality characteristics during storage, indicating that the products maintain their desired properties for extended periods. Specifically, the progressive increase in pH and moisture content, alongside the gradual decline in titratable acidity, ascorbic acid, reducing sugars, total sugars, and phenolic content, reflects the products' overall stability. This stability is crucial for ensuring the long-term usability and consumer satisfaction of these instant products.

Overall, the investigation provides a solid foundation for the development of nutritious and high-quality instant potato products. The standardised methods and findings can be applied to future product innovations, contributing to the advancement of potato-based food products in the market. This research not only enhances understanding of potato starch extraction and product formulation but also opens avenues for further exploration and development in the field of instant food products.

(**Author Contributions:** D. Semwal conducted the experiments, standardized recipes, and drafted the manuscript. G. Abrol supervised the sensory evaluation and statistical analysis. J. Upraity designed the study, and finalized the manuscript.)

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