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Physico-chemical analysis of quinoa flour cookies

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Abstract
The present investigated was carried out to standardize recipe for preparation of cookies from different combination of quinoa and wheat flour. The main aims and objectives of this study to evaluate effect of different combination of baking temperature and time on experimental quinoa flour cookies and to evaluate the physico-chemical of experimental cookies. After analysis it was found that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective D.F. due to treatments and temperature. It was also showed significant difference ($p \leq 0.05$) between different treatments of all parameters.

Keywords: Quinoa, carbohydrates, fats, proteins, cookies, bakery, wheat flour

Introduction
Quinoa (*Chenopodium quinoa* Willd.) is a seed-producing crop, which has been cultivated in the Andes for thousands of years. Some ancient civilizations (Aztec, Mayan, and Incan) used it as a staple cuisine (Caperuto *et al*., 2001) [3]. Quinoa was first cultivated seven thousand years ago in South America, and it is currently gaining popularity as an alternative crop around the world (Caperuto *et al.*, 2001; Comai *et al.*, 2007; Gely and Santalla, 2007) [3, 4, 10]. Quinoa output has risen dramatically in the previous two decades, particularly in Bolivia. Bolivia, Peru, and Ecuador are the largest producers, with 61,490 tons produced in 2007, up from 19,000 tons in 1973 (FAOSTAT, 2008) [8]. In 2007, Peru produced 34,000 tons of quinoa, Bolivia 26,800 tons, and Ecuador 690 tons (FAOSTAT, 2008) [8]. The United Nations designated 2013 as the International Year of Quinoa in honor of its enormous potential. Quinoa is abundant in protein, all essential amino acids, unsaturated fatty acids, and has a low glycemic index (GI); it also includes vitamins, minerals, and other useful substances, and is naturally gluten-free. Quinoa is a versatile grain that is simple to prepare (Tang *et al.*, 2015) [18].

Quinoa is abundant in vitamins A, B2, E, and minerals like calcium, iron, zinc, magnesium, and manganese, making it beneficial to a variety of target populations: Adults and children, for example, benefit from calcium for their bones and iron for their blood processes. Quinoa is a pseudo-cereal that contains high-quality proteins, phytosteroids, and omega-3 and 6 fatty acids that are beneficial to human health (Farinazzi-Machado *et al.*, 2012) [9]. Because of its peculiar nutritional composition, the edible seed of the quinoa plant has been dubbed both a pseudo-cereal and a pseudo-oil seed. When compared to ordinary cereals, the nutrition profile is excellent (Demir, 2014) [5]. Quinoa oil content varies between 1.8 and 9.5 percent (Vega-Gálvez *et al.*, 2010) [20]. It has been observed that it contains about 70% unsaturated fatty acids, with linoleic (38.9%) and oleic acids (27.7%) (Dini *et al.*, 2010) [7]. Quinoa protein is also high in the amino acids methionine, lysine, and cysteine Quino is a gluten-free, exceptionally healthy meal from the twenty-first century (Valencia-Chamorro, 2003) [19]. Quinoa has been designated by the FAO as a good alternative crop for ensuring food security and preventing poverty in the twenty-first century (Miranda *et al.*, 2014; Ruiz *et al.*, 2014) [22, 16]. As a result, the United Nations General Assembly declared 2013 to be the International Year of Quinoa.

Wheat is one of the most widely used and studied cereals, owing to gluten's rheological and baking properties. The bread-making appropriateness of QF and wheat flour (WF) mixtures has been examined. Alvarez-Jubete and colleagues (2010) In India, the baking industry is one of the most important divisions of the food processing industry. Baked goods are becoming more popular as a result of their accessibility, ready-to-eat convenience, and long shelf life. Cookies are a popular snack item due to their range of flavors, crispiness, and digestibility.

Cookies are produced using a range of components such as sugars, spices, chocolates, butter, peanut butter, almonds, and dried fruits (Tewari, 2019) [21]. Due to its low manufacturing cost, convenience, long shelf life, good eating quality, and capacity to serve as a carrier for key nutrients, cookies have become one of the most popular snacks for people of all ages (Demir & Kılınç, 2017) [6]. Consumers are purchasing products that delight their taste buds in addition to healthy alternatives. The taste enjoyment aspect is critical in the market, as consumers increasingly seek premium and exotic products to satisfy their desire to indulge, thanks to the wide selection of bakery items accessible. The bakery industry's usual decadent items include cakes, pastries, biscuits, and cookies. Cookies are one of India's most popular and extensively consumed manufactured food products because they are ready to eat, handy, and economical (Shukla and Choudhary, 2022) [17]. Customers Cookies are the most popular snack item among baked dishes all across the world. Cookies are popular among bakery items and snack meals because of their range of flavors, crispiness, digestibility, and longer shelf life.

Quinoa competes with lower-cost ancient grains like spelt, barley, and millet in the bakery market. It has strengthened its position in the more upscale consumer goods market. Quinoa is a nutrient-dense grain that is less commonly utilized in its unprocessed form. Cookies are now commonly used as a sweet in households, thus it is necessary to make them healthful. Nutrient availability, palatability, compactness, and convenience are all advantages of cookies. They vary from other bakery items such as bread and cakes in that they have a low moisture content, are relatively free of microbial deterioration, and have a long shelf life. Due to its low manufacturing cost, convenience, long shelf life, good eating quality, and capacity to serve as a carrier for key nutrients, cookies have become one of the most popular snacks for people of all ages. As a result, Quinoa is used to make cookies, and no research have been conducted on the analysis of cookies made from Quinoa. As a result, it is necessary to investigate the health benefits of Quinoa Cookies.

In India, a growing number of customers are becoming aware of the need of a nutritious diet. Quinoa is a good example of the nutritious "super foods" that have gotten a lot of press in recent years. Much of the increase in quinoa imports can be linked to consumer perceptions of the grain's healthy and nutritious qualities.

The desire for better-for-you foods will continue to rise. Quinoa isn't the only upcoming healthy grain on the market, but it will continue to thrive in specialized markets like gluten-free. Quinoa is a unique product that may be used in place of regular grains like rice or wheat, as well as high-value elements in grain blends and processed foods. This study forms the foundation for this research.

Objective

1. To standardize recipe for preparation of cookies from different combination of quinoa and wheat flour.
2. To Evaluate effect of different combination of Baking Temperature and Time on Experimental Quinoa flour cookies.
3. To evaluate of physico-chemical of experimental cookies.

Materials and Methods

The experiments related to “Assessment of Nutritional Value and Effect of Baking time and Temperature on Quality of Quinoa Cookies for Flour Cookies” carried out in the research laboratory of Food science and Technology, Warner college of Dairy Technology, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (U.P.).

Procurement of raw material

For preparation of Quinoa Flour Cookies, the raw ingredients like Wheat Flour, Quinoa flour, sugar, Fat, Baking Powder were purchased from local market of Prayagraj.

Procurement and collection of ingredients

1. **Quinoa:** Purchased from local market of Prayagraj.
2. **Wheat flour:** Purchased from local market of Prayagraj.
3. **Sugar:** Sugar will be collected from local stores of Prayagraj.
4. **Fat:** Purchased from local market of Prayagraj.
5. **Baking powder:** It will be collected from local market of Prayagraj.

The composition blend flour cookies where prepared using the basic formula developed

Ingredients	Quantity (%)
Wheat flour	60
Sugar	19
Fat	21
Sodium Bicarbonate	0.2
Ammonium	O.2
Water	As per requirements

Treatment combination

T_0 = Quinoa Flour (0%): Wheat Flour (100%) + Baking at 175 °C for 15 Mins.

T_1 = Quinoa Flour (10%): Wheat Flour (90%) + Baking at 175 °C for 15 Mins.

T_2 = Quinoa Flour (20%): Wheat Flour (80%) + Baking at 175 °C for 15 Mins.

T_3 = Quinoa Flour (30%): Wheat Flour (70%) + Baking at 175 °C for 15 Mins.

T_4 = Quinoa Flour (40%): Wheat Flour (60%) + Baking at 175 °C for 15 Mins.

T_5= Quinoa Flour (50%): Wheat Flour (50%) + Baking at 175 °C for 15 Mins.

T_6 = Quinoa Flour (60%): Wheat Flour (40%) + Baking at 175 °C for 15 Mins.

T_7 = Quinoa Flour (10%): Wheat Flour (90%) + Baking at 180 °C for 15 Mins.

T_8 = Quinoa Flour (20%): Wheat Flour (80%) + Baking at 180 °C for 15 Mins.

T_9 = Quinoa Flour (30%): Wheat Flour (70%) + Baking at 180 °C for 15 Mins.

T_{10} = Quinoa Flour (40%): Wheat Flour (60%) + Baking at 180 ^{0}C for 15 Mins.

T_{11} = Quinoa Flour (50%): Wheat Flour (50%) + Baking at 180 ^{0}C for 15 Mins.

T_{12} = Quinoa Flour (60%): Wheat Flour (40%) + Baking at 180 °C for 15 Mins.

T_{13} = Quinoa Flour (10%): Wheat Flour (90%) +Baking at 185 °C for 10 Mins.

T_{14} = Quinoa Flour (20%): Wheat Flour (80%) + Baking at 185 °C for 10 Mins

T_{15} = Quinoa Flour (30%): Wheat Flour (70%) + Baking at 185 °C for 10 Mins.

T_{16} = Quinoa Flour (40%): Wheat Flour (60%) + Baking at 185 °C for 10 Mins.
T_{17} = Quinoa Flour (50%): Wheat Flour (50%) + Baking at 185 °C for 10 Mins.
T_{18} = Quinoa Flour (60%): Wheat Flour (40%) + Baking at 185 °C for 10 Mins.
Heat Treatment$_1$/HT_1= Baking at 175 °C for 15 Mins.
Heat Treatment$_2$/HT_2= Baking at 180 °C for 15 Mins.
Heat Treatment$_3$/HT_3= Baking at 185 °C for 10 Mins.
No. of Treatment: 18 +1 =19
No of replication: 05
Total no of trials: 95

Physico-chemical Analysis

- Carbohydrates (%)
- Protein (%)
- Fat (%)
- Ash (%)
- Moisture (%)
- Crude fibre (%)
- Energy (Kcal/gm)

Physicochemical analysis of final prepared Cookies

1. Fat (%) was estimated as per procedure laid down in IS: 1166, (1973).
2. Protein (%) was estimated as per the procedure suggested by Maneffee and Overman (1940).
3. Carbohydrates (%) was estimated as per the procedure (By Lane Eynon method, SP: 18, Part XI, 1981).
4. Ash (%) was estimated as per the procedure laid down in IS: 5962 (1970) [14].
5. Energy (Kcal) was estimated as per the procedure laid down in IS: 5962 (1970) [14].
6. Moisture (%) was estimated as per the procedure laid down in IS: 5962 (1970) [14].
7. Total Fibre (%) was estimated by standard AOAC 2000 [1] method.

3.6.3 Statistical analysis

To determine the statistical significance of the research data, Factorial Analysis and Critical difference (C.D) used for physico-chemical and antioxidant parameters for developed cookies and Two-Way Analysis of Variance (ANOVA) technique and Critical difference (C.D) was used for developed dough. Means & SD's were calculated for all analysis. All values are expressed as mean and standard deviation of five parallel measurements.

Results and Discussion

The present study entitled "Physico-chemical analysis of Quinoa flour cookies" was conducted to Standardize recipe for preparation of cookies from different combination of quinoa and wheat flour, to Evaluate effect of different combination of Baking Temperature, Time and Thickness on Experimental Quinoa flour cookies, to evaluate of physico-chemical properties of Experimental cookies, to Study storage of Experimental quinoa flour Cookies at ambient temperature, to Estimate the cost of the product.
The results obtained are presented and discussed under following headings.

Table 1: Physico-chemical properties of final prepared cookies

Treatment Combination	Energy Kcal/100gm	Carbohydrates (%)	Protein (%)	Fat (%)	Ash (%)	Moisture content (%)	Crude Fiber (%)
Baking at 175º C for 15 Mins							
T_0	525.08	58.86	6.93	31.1	1.82	1.29	2.34
T_1	525.58	58.45	8.1	31.1	1.21	1.14	2.45
T_2	525.99	58	8.32	31.1	1.42	1.16	2.69
T_3	527.41	57.76	8.46	31.39	1.29	1.1	2.71
T_4	529.45	56.36	8.62	31.41	2.54	1.07	2.75
T_5	536.41	55.56	8.82	31.59	2.99	1.04	2.80
T_6	537.52	54.54	8.9	31.64	3.89	1.03	2.82
Baking at 180 °C for 15 Mins							
T_7	525.08	58.86	6.2	31.11	2.78	1.05	2.32
T_8	525.58	59.99	6.21	30.68	2.09	1.03	2.41
T_9	525.99	58.85	6.25	31.35	2.5	1.05	2.60
T_{10}	527.41	58.76	6.28	31.28	2.67	1.01	2.67
T_{11}	531.33	57.83	6.32	31.58	3.26	1.01	2.70
T_{12}	537.52	57.54	6.35	31.65	3.44	1.02	2.78
Baking at 185 °C for 10 Mins							
T_{13}	514.07	59.81	5.2	31.15	2.84	1	2.28
T_{14}	515.56	60.01	5.23	31.28	2.47	1.01	2.31
T_{15}	517.19	60.87	5.26	30.35	2.52	1	2.34
T_{16}	517.41	60.66	5.27	30.38	2.68	1.01	2.44
T_{17}	519.23	62.23	5.31	29.38	2.06	1.02	2.46
T_{18}	520.54	62.34	5.36	29.45	1.82	1.03	2.49

Table 2: Energy content (Kcal) of final prepared cookies

ANOVA						
Source	**DF**	**SS**	**M.S.S.**	**F Cal**	**F Tab 5%**	**Result**
Due to replicate	4	60.0801	15.0200	1.485	2.47	NS
Due to Treatments	8	1235.5761	154.4470	15.266	2.04	S
Due to temp	2	2613.8524	1306.9262	129.1818	3.10	S
Error	90	910.5258	10.1170	-	-	-
Total	104	4820.03	-	-	-	-

The above ANOVA table is showing that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective D.F. due to treatments and temperature. The above table also showing significant difference ($p \leq 0.05$) between different treatments.

It was also found that the cookies that are treated with 175 °C and 180 °C, contains high energy than 185 °C heat treatment process. In case of 185 °C heat treatment process, the cookies contain lower energy. The highest mean value in 175 °C and 180 °C, T_6 has high energy content

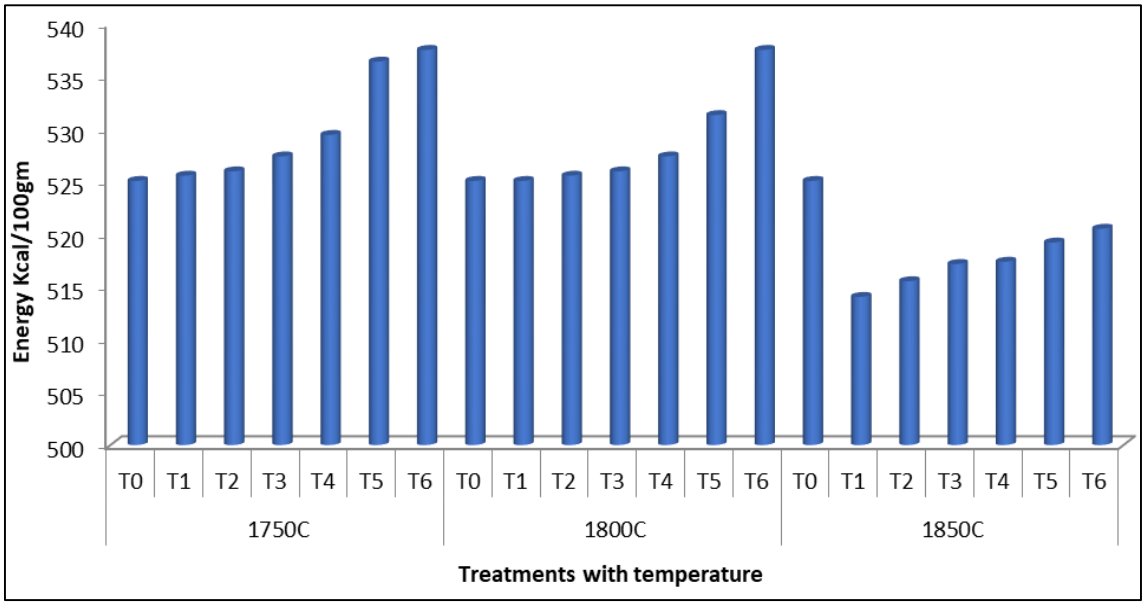

Fig 1: Graphical representation of total energy content (%) of cookies

Table 3: Carbohydrate percentages of final prepared cookies

ANOVA						
Source	**DF**	**SS**	**M.S.S.**	**F Cal**	**F Tab. 5%**	**Result**
Due to replicate	4	0.0563	0.0141	0.003	2.47	NS
Due to Treatments	8	135.0043	16.8755	3.917	2.04	S
Due to temp	2	8.7523	4.3762	1.0158	3.10	NS
Error	90	387.7110	4.3079	-	-	-
Total	104	531.52	-	-	-	-

The above ANOVA table is showing that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective D.F. due to treatments. The above table also showing significant difference ($p \leq 0.05$) between different treatments.

It was found that the cookies that are treated with 175 °C and 180 °C, contain high carbohydrate percentages than 185 °C heat treatment process. In case of 185 °C heat treatment process, the cookies contain lower carbohydrate percentages. The highest mean value in 175 °C, 180 °C and 185 °C; T_1, T_2 and T_5 has high carbohydrates content respectively

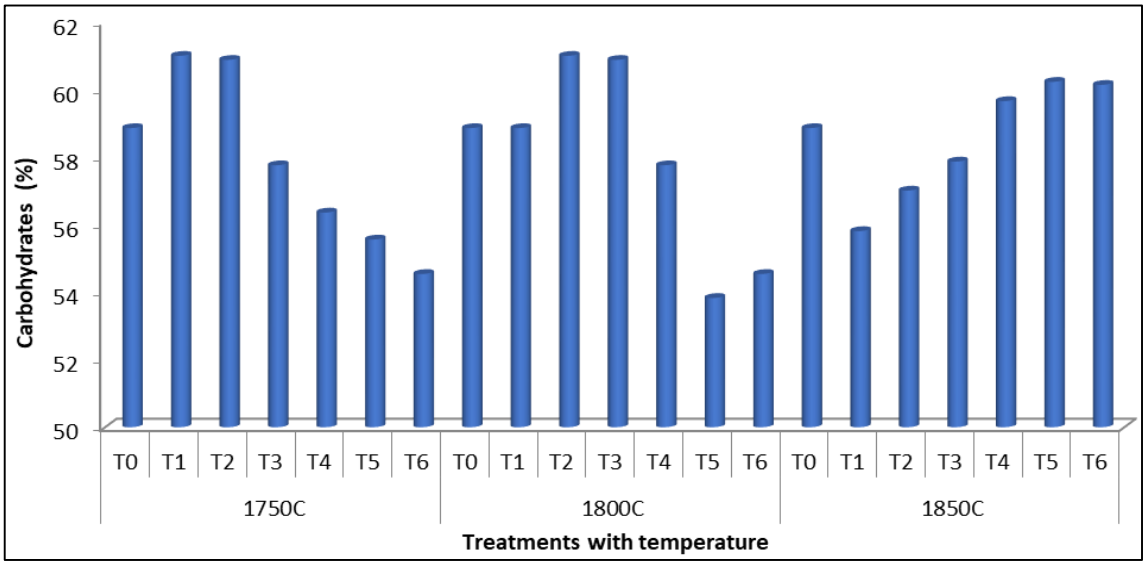

Fig 2: Graphical representation of total Carbohydrates (%) of cookies

Table 4: Protein percentages of final prepared cookies

ANOVA						
Source	**DF**	**SS**	**M.S.S.**	**F Cal**	**F Tab. 5%**	**Result**
Due to replicate	4	0.0761	0.0190	0.064	2.47	NS
Due to Treatments	8	4.9576	0.6197	2.080	2.04	S
Due to temp	2	131.4973	65.7487	220.6480	3.10	S
Error	90	26.8182	0.2980	-	-	-
Total	104	163.35	-	-	-	-

It was found that that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective DF due to treatments and temperature. The above table also showing significant difference ($p \leq 0.05$) between different treatments

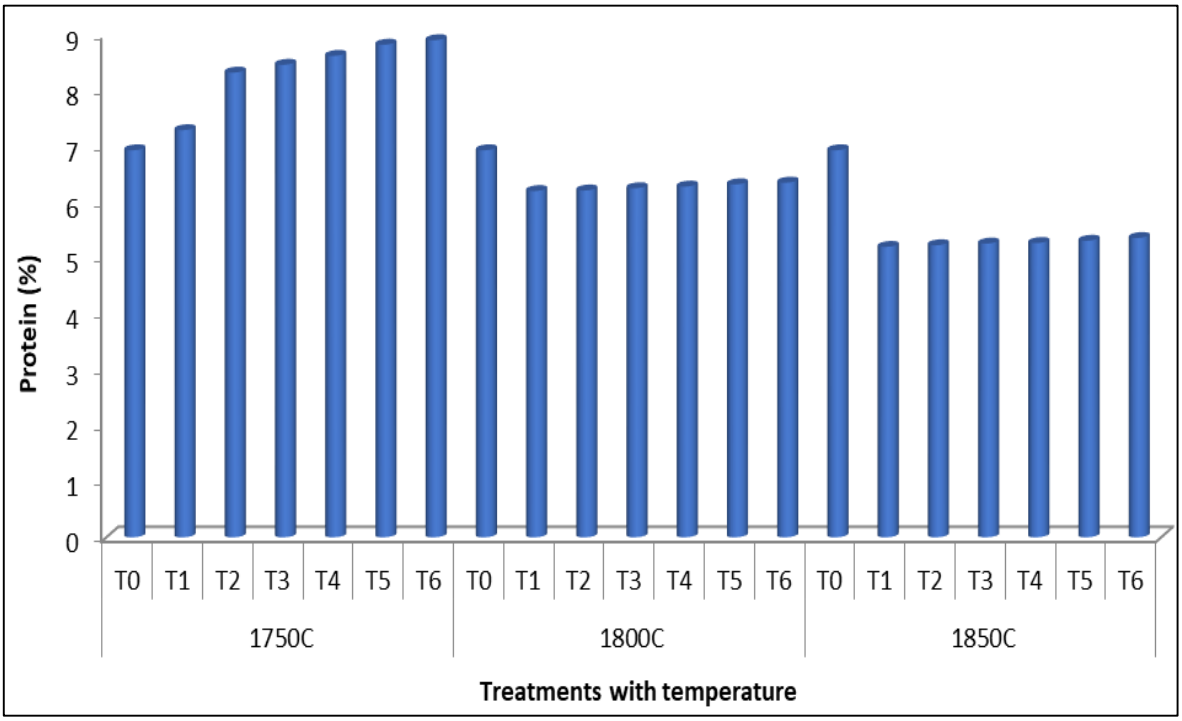

Fig 3: Graphical representation of total Protein (%) of cookies

The above graph is showing that the cookies that are treated with 175 °C, contains high protein percentages than 180 °C and 185 °C heat treatment process. In case of 180 °C and 185 °C heat treatment processes, the cookies contain lower protein percentages. The highest mean value in 175 °C, 180 °C and 185 °C, T_6, T_0 and T_0 has high protein content respectively

Table 5: Fat percentages of final prepared cookies

ANOVA						
Source	**DF**	**SS**	**M.S.S.**	**F Cal**	**F Tab. 5%**	**Result**
Due to replicate	4	0.0653	0.0163	0.413	2.47	NS
Due to Treatments	8	2.2770	0.2846	7.195	2.04	S
Due to temp	2	18.3328	9.1664	231.7282	3.10	S
Error	90	3.5601	0.0396	-	-	-
TOTAL	104	24.24	-	-	-	-

The above ANOVA table is showing that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective D.F. due to treatments and temperature. The above table also showing significant difference ($p \leq 0.05$) between different treatments.

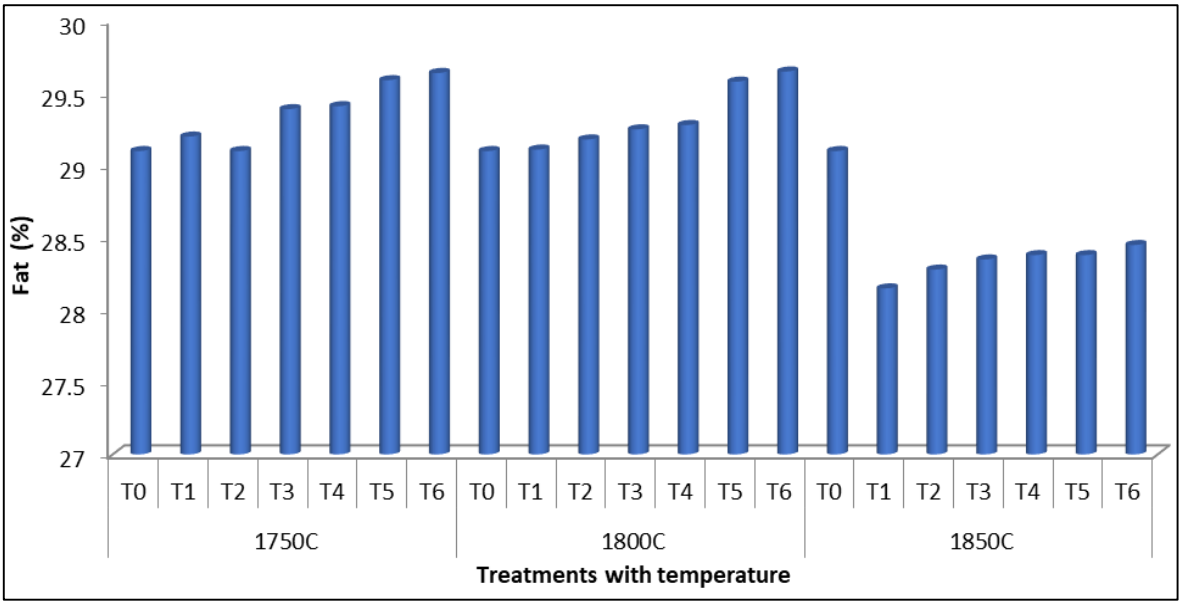

Fig 4: Graphical representation of total fat (%) of cookies

The above graph is showing that the cookies that are treated with 175 °C and 180 °C, contain high fat percentages than 185 °C heat treatment process. In case of 185 °C heat treatment process, the cookies contain lower fat percentages. The highest mean value in 175 °C, 180 °C and 185 °C; T_6, T_6 and T_0 has high fat content respectively.

Ash percentages of final prepared cookies

The above ANOVA table is showing that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective D.F. due to treatments and temperature. The above table also showing significant difference ($p \leq 0.05$) between different treatments.

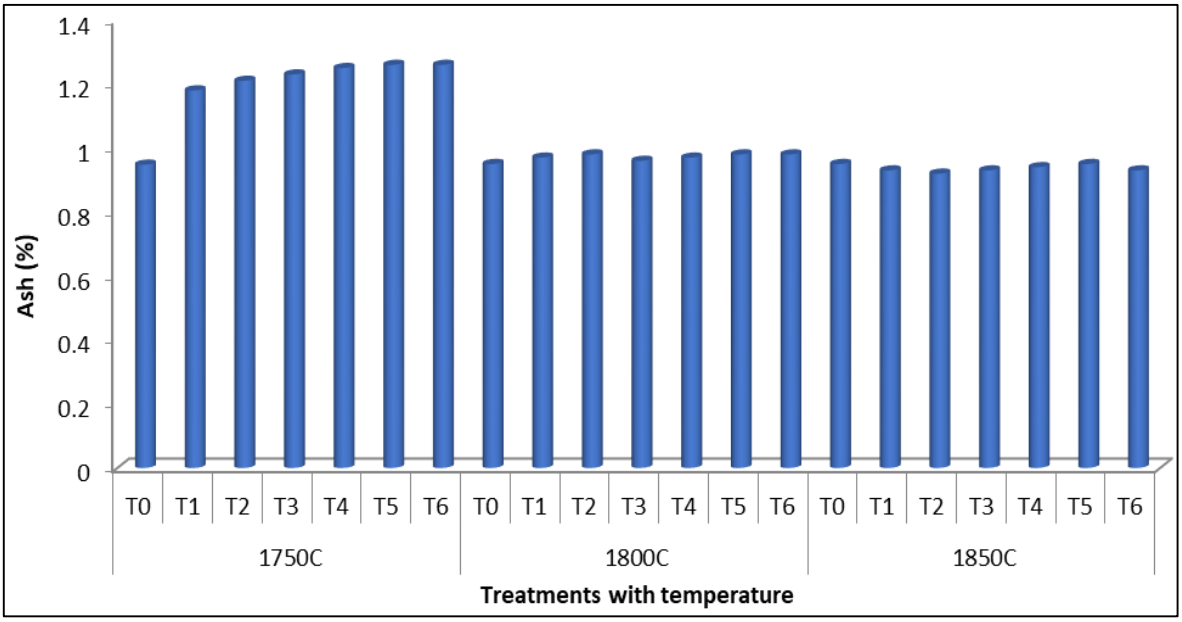

Fig 5: Graphical representation of total ash (%) of cookies

The above graph is showing that the cookies that are treated with 175 °C and 180 °C, contain high ash percentages than 180 °C and 185 °C heat treatment process. In case of 185 °C heat treatment process, the cookies contain lower ash percentages. The highest mean value in 175 °C, 180 °C and 185 °C; T_5 &T_6, T_5, T_6, T_0 & T_5 has high ash content respectively.

Moisture percentages of final prepared cookies

The above ANOVA table is showing that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective DF due to replication, treatments and temperature. The above table also showing significant difference ($p \leq 0.05$) between different treatments.

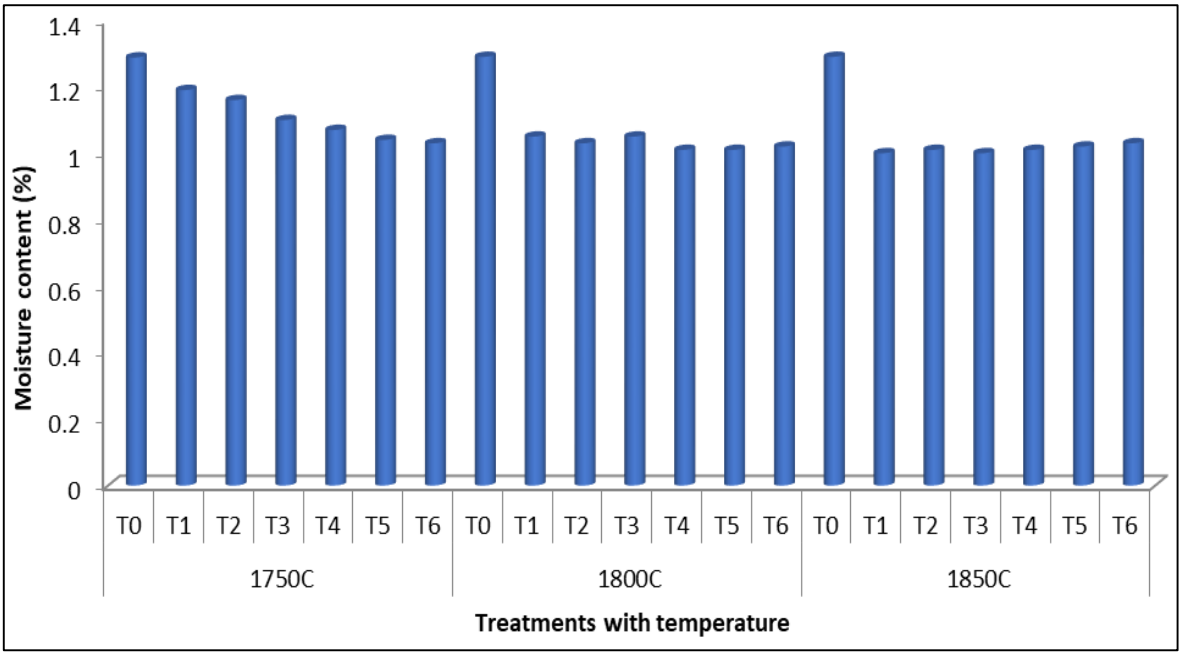

Fig 6: Graphical representation of total Moisture content (%) of cookies

The above graph is showing that the cookies that are treated with 180 °C and 185 °C, contain high moisture percentages than 175 °C heat treatment process. In case of 175 °C heat treatment process, the cookies contain lower moisture percentages. The highest mean value in 175 °C, 180 °C and 185 °C; T_0 has high moisture content.

Table 6: Crude fiber percentages of final prepared cookies

ANOVA						
Source	**d. f.**	**S.S.**	**M.S.S.**	**F. Cal.**	**F. Tab. 5%**	**Result**
Due to replicate	4	0.0243	0.0061	1.268	2.47	NS
Due to Treatments	8	0.1347	0.0168	3.513	2.04	S
Due to temp	2	1.3449	0.6724	140.2545	3.10	S
Error	90	0.4315	0.0048	-	-	-
TOTAL	104	1.94	-	-	-	-

The above ANOVA table is showing that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective D.F. due to treatments and temperature. The above table also showing significant difference ($p \leq 0.05$) between different treatments.

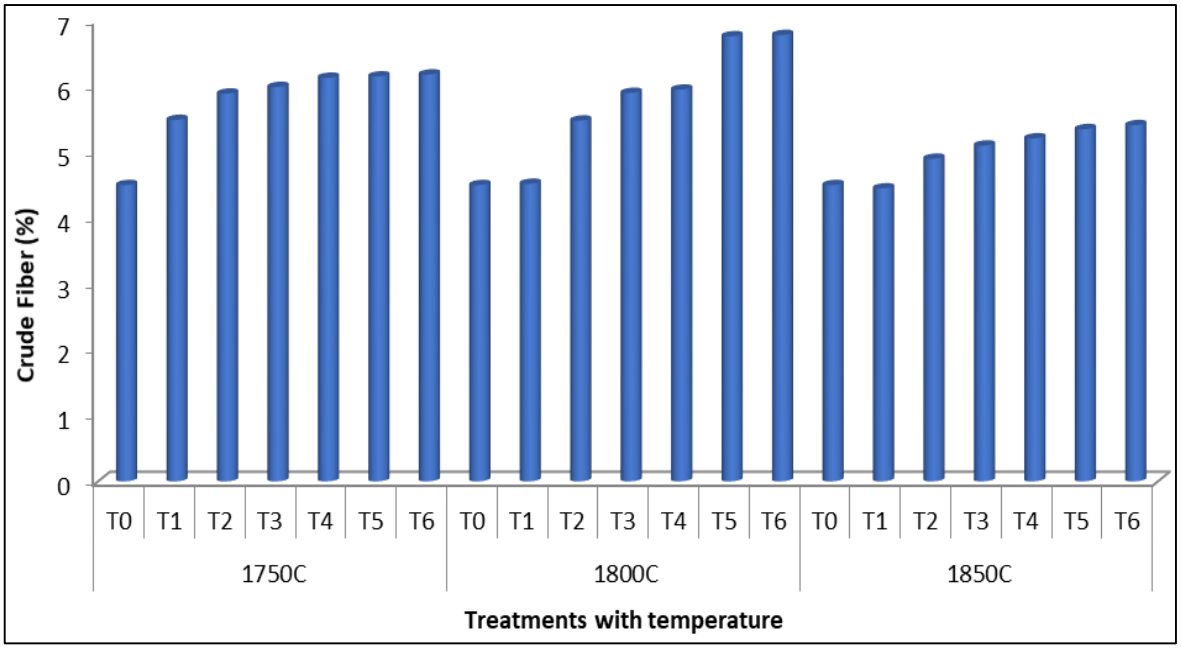

Fig 7: Graphical representation of total Crude Fiber (%) of cookies

The above graph is showing that the cookies that are treated with 175 ºC and 180 ºC, contain high crude fiber percentages than 185 ºC heat treatment process. In case of 185 ºC heat treatment process, the cookies contain lower crude fiber percentages. The highest mean value in 175 ºC, 180 ºC and 185 ºC; T_6 has high crude fiber content respectively.

Conclusion

Cookies heated to temperatures of 175 ºC and 180 ºC contain more energy than cookies heated to 1850 ºC. The cookies have less energy when they are heated to 185 ºC. T_6 has a high mean value and a high energy content at 175 and 180 degrees Celsius. Cookies heated to temperatures of 175 ºC and 180 ºC have higher carbohydrate contents than cookies heated to 185 ºC. The cookies had lower percentages of carbohydrates when heated to 185 ºC. T_1, T_2, and T_5, which had the highest mean values in 175 ºC, 180 ºC and 185 ºC, respectively, have significant carbohydrate contents. Compared to 180 ºC and 185 ºC heat treatment processes, 175 ºC cookies have higher protein percentages. Cookies using heat treatment methods at 180 °C and 185 °C have decreased protein content. T_6, T_0 and T_0, which had the highest mean values in 175 ºC, 180 ºC, and 185 ºC, respectively, have significant protein content. Cookies heated to temperatures of 175 °C and 180°C had more fat content than cookies heated to 185 °C. Lower fat percentages are present in the cookies when they are heated to 185 ºC. T_6, T_6, and T_0, which had the highest mean values in 175 ºC, 180 ºC, and 185 ºC, respectively, have significant fat contents. Cookies heated to 175 and 180 degrees Celsius have higher percentages of ash than cookies heated to 180 and 185 degrees Celsius. Lower ash percentages are present in the cookies when they are heated to 185 ºC. The greatest mean values at 175 ºC, 180ºC, and 185 ºC, T_5, T_6, T_5, T_6, T_0 & T5, respectively, have substantial ash contents. Cookies heated to 180 ºC and 185 ºC have higher moisture percentages than cookies heated to 175 ºC. Lower moisture percentages are seen in the cookies after the 175 ºC heat treatment process. T_0 has a high moisture content with the highest mean value at 175 ºC, 180 ºC, and 185 ºC. Cookies heated at 175 ºC and 180 ºC have higher percentages of crude fiber than cookies heated to 185 ºC. Lower crude fiber percentages are present in the cookies after the 185 ºC heat treatment method. T6 has a high crude fiber content, with the highest mean values at 175 ºC, 180 ºC, and 185 ºC, respectively. The above ANOVA table is showing that the F. Cal. Value is higher than the F. Tab. value at 5% significant level on their respective D.F. due to treatments and temperature. It was also showed significant difference ($p \leq 0.05$) between different treatments of all parameters.

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