The Pharma Innovation Journal 2023; 12(7): 2417-2421

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(7): 2417-2421

www.thepharmajournal.com
Received: 11-05-2023
Accepted: 22-06-2023

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Effect of batter viscosity on the quality of waffle cones

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Abstract
In the present study, the effect quality characteristics of batter such as the viscosity, moisture content and density were observed on various parameters of waffle cones *viz*., baking loss, thickness, weight, moisture content, and crispiness. The batter density was recorded as 1.04-1.25 g/cm^3. It was observed that the water content possessed a non-significant effect on the density, but significantly affected the viscosity and consistency of the batter. the viscosity of batter was optimized at different levels of water ranging between a viscosity of 4500-5000 mPas. For the preparation of high quality waffle cones, 2-3 parts of water and a baking time of 2 min at 150 °C temperature was found to be adequate. The waffle cone baking loss, thickness, weight, moisture content and crispiness were recorded as 65.93-66.33%, 2.58-2.77 mm, 10.12-10.23 g, 8.37- 8.53% and 9.00-20.00, respectively. The goal of this research was to investigate how waffle quality (stability) and sticking behaviour were affected by batter components. However, waffles have received relatively little research overall, there is currently no comprehensive scientific understanding of these occurrences.

Keywords: waffle cones, viscosity, consistency, quality, baking

Introduction
A waffle cone, often known as an ice cream cone, is a conical-shaped, crispy baked product used to serve ice cream. The waffle cone's distinctive texture, which contrasts with the texture of ice cream, makes it popular Phuenpipob *et al* (2016) [19]. Traditionally, flat waffle-shaped batter is baked before being rolled while still warm and malleable into conical shapes. The baked waffles releasing from the baking plates, may be attributed to the rheological properties of the batter, is one of the essential components for uninterrupted operation when employing automated equipment (Wade, 1988) [26]. The two types of ice cream cones are wafer (or cake) or moulded cones and rolled sugar cones Huang (1981) [23]. Ice cream cones are a crucial component of the production and marketing of novelty frozen desserts. Rolling flat waffles into conical shapes while they are still warm and malleable is how rolled ice cream cones, are prepared Huang (1990) [24]. Although refined wheat flour makes up a substantial part of this product, it lacks nutritionally important dietary fibre and amino acids. Dewettinck *et al* (2008) [11].

Waffle cones are made with ingredients such as flour, water, shortening, lecithin, sugar, salt, colourants, and flavourings. Some recipes tend to produce wafers that stick to the baking plates, time-consuming and difficult manual removal. In extreme circumstances, production must stop until an appropriate batter can be made. Thin batters are usually connected with sticking issues, but thick batters may make uniform batter application difficult. Hence, batter quality and the corresponding tendency for adhesion become regulating elements for successful baking Huang (1988) [25].

The characteristics of the flour, water temperature and level, mixing technique, baking time, and temperature are the primary factors affecting the waffle cone's quality. The batter's qualities, including holding time, density, viscosity, and temperature, as well as the waffle cone's weight, surface colour, fragility, and moisture content, are used to determine the quality (Dogan, 2006) [6]. The batter used to make the waffle cone contains 35–40 percent dry matter (Anonymous, 1989) [1].

While distributing batter and develop a good quality waffle cone, the required viscosity is vital. Waffle cone recipes should have enough water (moisture contents of 55–60%) to evenly distribute the ingredients and provide a viscosity that is low enough to flow over and cover the plate (Kobs, 2001) [13]. As water levels influence the texture of the waffle sheet, water reduces the sheet's fullness, resulting in thick, heavy, and unbaked sheets. so, the flour to water ratio should be kept under control. Excess water cannot hold the batter's viscosity. Water also serves as a leavening agent during baking (Wade, 1988) [26].

Materials and Methods

Commercial wheat flour, butter, sugar powder, banana and milk bought from the near market were used for the study. Fresh apple pomace was procured from the canning unit Department of Food Science and Technology, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. The pomace was treated with potassium metabisulphite (1000ppm) and dried in a cabinet tray drier at 50 ± 2˚C for 24 h. Dried pomace was then ground in a Willey grinder and passed through a 30 mm mesh screen sieve (500 µm). Ground apple pomace was packed polyethylene bag, labeled and kept for storage in a cool and dry place.

Batter preparation

The batter ingredients and their proportions are represented in Table 1. Sugar powder and melted butter were mixed then the mashed banana and milk were added. Dry ingredients such as flours were mixed separately (wheat flour and apple pomace flour). The total mixing duration of the batter depended on the constancy of the batter. To allow air bubbles to rises to the surface, the batter was then let to stand for 10 minutes. The temperature of the batter was maintained at 25 ± 2 °C throughout the experiment.

Table 1: Waffle cone ingredient

Treat.	APF (g)	WF (g)	SP (g)	Butter (g)	MP (g)	PS (g)
T1	20.00	8.00	10.00	10.00	10.00	2.00
T2	20.00	8.00	10.00	10.00	10.00	0.59
T3	20.00	8.00	10.00	10.00	14.24	2.00
T4	20.00	8.00	10.00	10.00	13.00	1.00
T5	20.00	8.00	10.00	10.00	10.00	3.41
T6	20.00	8.00	10.00	10.00	7.00	3.00
T7	20.00	8.00	10.00	10.00	13.00	3.00
T8	20.00	8.00	10.00	10.00	7.00	1.00
T9	20.00	8.00	10.00	10.00	5.76	2.00

Batter density and viscosity

By weighing a 100-ml graduated cylinder that was half filled with batter and half with water and dividing the weights, the density of the batter was determined. The viscosity of the waffle cone batter was measured by using a Brookfield viscometer (Model DV-III, Stoughton, MA, US). Waffle cone batter was transferred to a beaker of 100 ml, and filled to the brim. The spindle speed was set at 20 rpm and for all experiments, spindle No. 7 was used. Viscosity was measured immediately. The experiment was conducted at room temperature (25 ± 2 °C). pH was determined using a digital pH meter (Mettler Toledo).

$$\text{Density of batter} = \frac{W_1}{W_2} \times 0.997 \text{ gm/cm}^3$$

Where,
W_1 = Weight of batter
W_2 = Weight of water

Baking process

Laboratory-type wafer baking plates (Cone Baker Machine) were used to bake round wafer cone sheets. The temperature of the upper and lower plates was similar and controlled with digital thermocouples range of temperature 50 – 250 °C. The plates were warmed to the baking trial temperature. After feeding a portion of the batter weighing 30.00 g onto the middle of the lower plate's surface, the upper plate was swiftly shut, the lid was locked, and the temperature was kept at 150 °C for 2 minutes.

Results and Discussion

Quantity of water

The quantity of batter plays a very important role in the desired consistency of the batter. The amount of water depends on the concentration of dry ingredient quantity such as flour (apple pomace flour and wheat flour), sugar powder, milk powder and potato starch. However, the effects of flour concentrations on the water level of the batter were significant at $p<0.05$. The batter had a water level of 2-3 parts per 1 part of dry ingredients (apple pomace flour, wheat flour, sugar powder, milk powder and potato starch). This was due to the high-water absorption capacity (WHC) of flour which depends upon the quantity of starch and dietary fiber present (Chandra and Patel, 2013) [2]. According to Table 2, among all treatments, a higher WHC was observed in the treatment (T7), due to the higher concentration of milk powder and potato starch than the other treatments. Santana *et al*. (2022) [5] showed that the flour with high fiber and protein content, water is essential to get a good mixture of the batter and the cone prepared from high absorption end to be hard and ultimately crispier. A similar statement was given by Hadiyanto *et al*. (2007), that the crispiness is reliant on the availability of water content and the gelatinization of starch during baking.

Viscosity

The amount of water, gluten, starch, fibre, and the time after mixing had affected the viscosity of the batter. As per Table 2, the relationship between batter viscosity and water level was highly significant at $p<0.05$. The total water level in the treatments used in the study ranged from 2-3 times more than on a dry ingredient weight basis. The steam vents enable the moisture in the batter to escape as soon as the plates are touched. The batter is spread evenly throughout the space between the plates due to the quick steam production. A excellent wafer texture is achieved through the generation of water vapour (Manley, 2000) [15]. For any given solid content, variations in water level have an impact on the viscosity of the batter. Water is necessary to achieve the desired viscosity, as shown in Table 2. The viscosity was reduced as the water level raised. The viscosity was significantly enhanced when less than 2 to 3 parts of water were used, which led to issues including difficult batter deposit and incomplete sheets. The viscosity appears to change when gluten is added when the water content is less than 150%. The measurement of batter viscosity is more useful for making waffle cones than the measurement of density. The batter holding time was a significant factor impacting viscosity as well. The flour's lower a-amylase level is probably what caused the viscosity to decrease. Viscosity decreased less after 30 minutes than it did in the first 30. Viscosity reduction is additionally restricted by the low batter temperature and the fact that a-amylase only works on damaged starch. The impact of a-amylases on starch is minimal if the batter is used within 30 minutes of preparation (Matz, 1992; Manley, 2000) [17, 15].

Moisture content

The moisture content of waffle cone batter has also defined as the quality of batter that is a direct effect on the batter's viscosity and consistency. Waffle cones and wafers sheets are

produced from a batter containing 35-40 percent dry matter (Anonymous, 1989) [1]. Whereas higher moisture content in the batter was more liquid and during pouring the backing plate run outside of the plate and less moisture content in the batter that the low enough viscosity to flow of batter and decrease the completeness of the waffle cone sheet; therefore, thick, heavy and unbacked sheet occurs. As a result of evaporation during baking, water also functions as a leaving agent (Dogan, 2006) [6]. According to the result, moisture content was observed significantly higher at 61.60 percent in treatment (T7) and at least 60.50 in treatment (T3). As the above mention, the statement the dry matter (35-40%) was justified by the moisture content range of the batter. In order to get a suitable consistency, water is added. Since that the weight of the water is around 150% that of the flour, it is therefore crucial to give great attention to the flour metering in order to successfully produce homogenous batter. When compared to errors in flour weighing, changes in flour characteristics that effect water absorption are typically negligible.

Density

The density of batters ranged between 1.04 to 1.25 g/cm^3. The density may vary by temperature and mixing time depending on the amount of milk powder and potato starch added to the flour and water in the treatments. However, at $p<0.05$, the interactions between the amount of wheat and water and batter density were significant. The water content in the batter was 2-3 parts water to 1 part flour. Due to the high water content of the batter, less air was incorporated into the batter, which is why there were substantial variances in density. When the batter is applied volumetrically to the baking plate for making waffle cones, the density of the batter should fall within a specific range. In a previous studies, it was found that wafer batters without yeast had an average density of between 1.11 and 1.19 g/cm3 (Dogan, 2006) [6] and 1.14 to 1.15 g/cm3 (Wade,1988) [26]. Due to the low density, more air is likely to be present in the wafer batter, which is desirable because it will result in more gas bubbles in the wafers, more baking bubbles, and a bigger volume of the final product. A similar statement was given by Ekramiant *et al*., 2021 [9].

Baking loss (%)

Many variables, such as baking temperature, batter wetness, or ingredient, might affect baking loss. The values for baking loss were 65.93 percent for the treatment (T9) and
66.33 percent for the treatment (T7), respectively, compared to 56.12 percent baking losses in the case of the waffle sheet observed by Chetrariu and Dabija (2022), which is to be expected because the wafer humidity is much lower than that of waffles.

Thickness (mm)

The brittleness of the waffle cone is largely determined by its thickness, so the thinner the waffle cone, the more brittle it is. Throughout the course of the study, the gaps between the plates were maintained at more than 2.50 mm. The amount of batter placed, the bake time, and the temperature all had an impact on the waffle cone's thickness. Table 2 showed the effects of water level, ingredient composition and baking temperature on wafer thickness. Whereas a significantly higher thickness was recorded in the treatment (T3) and the least in the treatment (T7).

Weight (g) and Moisture (%)

Changes in the viscosity and composition of the batter have an impact on the weights and moisture of waffle cones. Lighter weights provide fragile, brittle, and soft-eating waffle cones, whereas heavier weights produce firmer wafers. There can be no shortages in the corners and each waffle cone must have the same weight. In order to guarantee that average weights are within a particular range that cone weights from subsequent plates are also within a certain range. The data are shown in Table 2 weight of the waffle cone is between 10.10 g to 10.23 g, respectively.

Waffle cone weight variations may be caused by unequal plate gap settings or uneven batter deposition, which is typically exhibited by uneven amount of bobble or partial sheets. Light wafers are less moist and lighter in colour than heavier wafers. The higher the distribution of the moisture is more asymmetrical the overall moisture content.

The stickiness of the batter is mostly caused by moisture content, however minor amounts of moisture also make the final products crisp and prolong the shelf life of food items (Schmidt *et al*., 2018) [21]. The results of this investigation were consistent with those by Raza *et al*. (2016) [20], who reported that the moisture of all treatments ranged from 8.33 to 8.53 percent. Wafers contain 7.00 percent moisture and have water activity less than 0.52, according to Matinez *et al*. (2004) [16], their results agree with those of Meral and Dogan (2004) [7]. They also demonstrated good shelf-life stability. During baking, most of the moisture evaporates, creating a porous foamed cellular structure. Although Navarrete *et al*. (2004) [18] suggested moisture levels between 6% and 11% for obtaining an acceptable crispy wafer.

Crispiness

The degree of crispiness is a crucial component of baked goods and has a significant impact on how consumers view them. The. According to (Szczesniak, 1972) [22], the sense of crispiness is equally important to freshness in the product and is a critical textural quality of bakery and confectionary food products for customer pleasure of foods. Table 2 showed the data of crispiness was observed between the range 9.00 to 20.00. The crispiness of the waffle cone was depended on the composition of the ingredient and water level as well as batter viscosity. The properties might be due to the high composition of fiber in apple pomace flour. High fiber content increased the texture of the cone to become crispy. Similar results were reported by Dom *et al*., 2020 [8] in the cone prepared using sweet potato and Kushwaha *et al*., 2023 [14] in a jackfruit seed flour-based ice cream cone. The most significant textural characteristic is thought to be wafer crispiness. Wafer texture is impacted by moisture level because it softens the starch-protein matrix, which changes how strong the wafer sheet is (Katz & Labuza, 1981) [12].

Table 2: Effect of batter on products quality

Treat.	Characteristics of batter				Characteristics of waffle cone				
	Water (ml)	Viscosity (mPas)	Moisture (%)	Density (g/cm)	Baking loss (%)	Thickness (mm)	Weight (g)	Moisture (%)	Crispiness
T1	85.00	4900	61.11	1.11	66.06	2.68	10.18	8.40	20
T2	82.00	4800	60.99	1.20	66.03	2.70	10.19	8.43	9
T3	90.00	5000	60.50	1.16	65.90	2.77	10.23	8.53	19
T4	85.00	4900	61.13	1.09	66.10	2.67	10.17	8.39	10
T5	90.00	5000	61.53	1.07	66.26	2.58	10.12	8.37	19
T6	80.00	4700	60.94	1.21	66.00	2.71	10.20	8.45	15
T7	92.00	5000	61.60	1.04	66.33	2.55	10.10	8.33	19
T8	78.00	4600	60.82	1.23	65.96	2.73	10.21	8.49	11
T9	76.00	4500	60.77	1.25	65.93	2.75	10.22	8.50	13
CD	1.72	16.55	0.01	0.02	0.02	0.02	0.02	0.02	1.72

Each value is the average of three replications: Above all the means value is significantly different at $p<0.05$ by CRD.

Conclusion

The present study revealed that the preparation of waffle cones can be successfully done by using apple pomace flour with wheat flour, sugar powder, butter, milk powder and potato starch. The water level and composition of ingredients and viscosity are important parameters for obtaining a high-quality waffle cone. As a processing parameter, water level, viscosity, density and moisture content were determined to prepare high-quality waffle cones. Water level and batter holding time were the variables that influenced batter viscosity. In order to produce a complete and crispy waffle cone, it was determined that batter viscosity should be controlled. The degree of changes caused by a-amylase in the viscosity of the prepared batter are minimal if used within 30 minutes. During the preparation of the batter, effective and quick mixing, temperature and viscosity controls are essential. According to the study, the batter's water content and baking temperature should be considered while adjusting the batter's quantity. Wafer sheet weight, a crucial factor in waffle brittleness and crispiness, was correlated with batter weight, baking time, and temperature. High-quality waffle cones were produced from a batter containing 2-3 parts of water level and baked at a temperature of 150 °C for 2 min.

Acknowledgment

We are thank full to the Department of Food Science and Technology, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, Indian Council of Agricultural Research and University Grant Commission.

Conflict of interest: None

Reference

1. Anonymous. Wafer Standard. TS 7474. Ankara, Turkey: Turkish Standards Institute; c1989.
2. Chandra S, Samsher S. Assessment of functional properties of different flours. African Journal of Agricultural Research. 2013;8(38):4849-4852.
3. Chetrariu A, Dabija A. Study of the Utilization of Spent Grain from Malt Whisky on the Quality of Wafers. Applied Sciences. 2022;12(14):7157-7163.
4. Craven HM, Swiergon P, Ng S, Midgely J, Versteeg C, Coventry MJ *et al*. Evaluation of pulsed electric field and minimal heat treatments for inactivation of pseudomonads and enhancement of milk shelf-life. Innovative Food Science & Emerging Technologies. 2008;9(2):211-216.
5. de Santana Silva C, Greiner R, Marinho LQM, Alves ASB, Cardoso LA, Maciel LF *et al*. Development of a gluten-free ice cream bask*et al*ternative using cowpea flour (*Vigna unguiculata* (L.) Walp), rice flour (*Oryza sativa*) and crude palm oil (*Elaeis guineensis* Jacq.). International Journal of Gastronomy and Food Science. 2022;28:421-431.
6. Dogan IS. Factors affecting wafer sheet quality. International Journal of Food Science and Technology. 2006;41(5):569-576.
7. Doğan İS, Meral R, Söylemez G. A study on the determination of the biscuit consumption habits. Dünya Gıda. 2004;10:62-65.
8. Dom ZM, Amin NAMZ, Kadir Basha R. Sweet potato peel flour applications in the textural quality of waffle ice cream cone and other food products. Advances in Agricultural and Food Research Journal. 2020;1:1-12.
9. Ekramian H, Saedi Asl M, Karimi M, Sheikholeslami Z, Pedram Nia A. Comparison the effect of fruits extract with fungal protease on waffle quality. Journal of Food Science and Technology. 2021;58(12):4766-4774.
10. Huang VT, Luebbers ST, Lindamood JB, Hansen PMT. Ice cream cone baking: 2. Textural characteristics of rolled sugar cones. Food Hydrocolloids. 1989;3(1):41-55.
11. Dewettinck K, Van Bockstaele F, Kühne B, Van de Walle D, Courtens TM, Gellynck X. Nutritional value of bread: Influence of processing, food interaction and consumer perception. Journal of Cereal Science. 2008;48(2):243-257.
12. Katz EE, Labuza TP. Effect of water activity on the sensory crispness and mechanical deformation of snack food products. Journal of Food Science. 1981;46(2):403-409.
13. Kobs L. B is for baking cookies. Food Product Design, October 2001.
14. Kushwaha R, Gupta A, Singh V, Kaur S, Puranik V, Kaur D. Jackfruit seed flour-based waffle ice cream cone: Optimization of ingredient levels using response surface methodology. Heliyon. 2023;9(2):121-133.
15. Manley D. Technology of biscuits, crackers and cookies Part 3. Woodhead Publishing Ltd. Cambridge, UK; c2000, p. 221–322.
16. Martínez-Navarrete N, Moraga G, Talens P, Chiralt A. Water sorption and the plasticization effect in wafers. International Journal of Food Science and Technology. 2004;39(5):555-562.
17. Matz SA. Cookie and Cracker Technology. Mc Allen, TX, USA: Pan-Tech International; c1992. p. 152-157.
18. Navarrete NM, Moraga G, Talens P, Chiralt A. Water

sorption and the plasticization effect in wafers. International Journal of Food Science and Technology. 2004;39:555-562.
19. Phuenpipob C, Thomthong D, Sakdumrong T. Utilization from Okara to replace wheat flour in ice-cream cone. Applied Mechanics and Materials. 2016;848:107-110.
20. Raza K, Nadeem M, Hussain S, Jabbar S, Din A, Qureshi TM. Development and physico-chemical characterization of date wafers. Journal of Agricultural Research. 2016;54(2):261-278.
21. Schmidt C, Geweke I, Struck S, Zahn S, Rohm H. Blackcurrant pomace from juice processing as partial flour substitute in Savoury crackers: Dough characteristics and product properties. International Journal of Food Science and Technology. 2018;53(1): 237-245.
22. Szczesniak AS. Consumer awareness of and attitudes to food texture II. Children and teenagers. Journal of Texture Studies. 1972;3(2):206-217.
23. Huang TV. The art and science of ice cream cone baking. The Ohio State University; c1981.
24. Huang VT, Lindamood JB, Hansen PMT. Ice cream cone baking: 3. Characterization of residues on baking plates. Food hydrocolloids. 1990;4(1):49-58.
25. Huang VT, Lindamood JB, Hansen PMT. Ice-cream cone baking: dependence of baking performance on flour and batter viscosity. Food Hydrocolloids. 1988;2(6):451-466.
26. Wade P. Biscuits, cookies, and crackers. Elsevier applied science; c1988.