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Effects of the Primary Components of Cake on Water Activity

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Abstract: **This article discusses the water activity (aw) of cakes and its relationship with temperature and the primary components of cakes. Water activity is an important factor that affects the shelf life, texture, flavour, and stability of food products, including cakes and affects quality of the food products. The study found that the water activity of cakes increased as the temperature rose between 20 and 30°C. The moisture content was identified as the most significant factor influencing the variation in water activity with temperature. Adjusting the moisture content during cake production can help maintain consistent water activity levels and improve product quality. The article aims to determine water activity in selected cake products at different temperatures and study the relationship between water activity and the contents of primary components in cakes.**

Keywords: **Bakery food products, water activity, moisture content.**

1. INTRODUCTION

The water activity (a_w) of a cake refers to the measure of the water vapor pressure in the cake relative to the vapor pressure of pure water at the same temperature and pressure. It is a dimensionless quantity that ranges from 0 to 1, where 0 represents completely dry and 1 represents pure water. Water activity is an important parameter in food science and food engineering, as it directly affects the shelf life, texture, flavour, and overall stability of food products, including cakes.

In the context of cakes, water activity is influenced by the ingredients used, the baking process, and storage conditions. Cakes typically have a low water activity due to the fact that they are baked, which reduces the moisture content. The sugar and other dry ingredients in the cake recipe also contribute to lowering the water activity by binding water molecules [1]. A low water activity is desirable in cakes because it helps prevent microbial growth and extends shelf life. High water activity can lead to issues such as mold growth and staleness. However, if the water activity is too low, the cake can become dry and less palatable. The specific water activity of a cake can varies depending on factors like the recipe, the moisture content of ingredients, and the degree of baking. It's important to note that while water activity is a critical factor, other aspects such as moisture content, formulation, and packaging also play a role in determining the overall quality and shelf life of cakes [2].

The aim of this paper has been to determine water activity in selected cake products at various temperatures and to study the degree of the dependence of this relationship on the contents of the primary components of cakes [3].

2. MATERIALS AND METHODS

2.1 Collection of samples:

Cakes have been collected from many bakeries in the Davangere city area and decorated samples were displayed in an open space. The collected samples were transported to the lab for examination in sterile polythene bags, where they were kept at a temperature of 25–27^{0}C for the fungal growth, which takes place over a period of seven days.

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2.2 Determination of Water activity:

Water activity was determined at the temperatures of 20, 25 and 30^{0}C in laboratory environment Prior to the measurement, the sample was carefully homogenised (for 5–10 s) in a mortar. The values of water activity represent the arithmetic means of at least four independent determinations at each temperature.

2.3 Determination of Humidity content:

Humidity content was determined after drying of the sample at the temperature of 102^{0}C to give a constant weight.

2.4 Nutrient contents determination:

Kjeldahl's technique was used to assess the protein content, and the Soxhlet equipment was used to extract the fat after acid hydrolysis. For an initial comparison of the products under study, the numbers for saccharide content were derived from the manufacturer's data listed on the packaging.

3. RESULT AND DISCUSSION

Within the range of aw between 0.11 and 0.29, water activity levels of samples tested at various temperatures were found **(Table. 1)**. Two samples (fruit cake and chocolate cake) had higher a_w values, ranging from 0.259 to 0.275. Additionally, these products had a higher moisture content (8–9%). The moisture levels of the other cake samples varied between 4 and 6%. Saccharides and lipids were present in considerable proportions in all of the studied samples in quite wide ranges (65-73% and 5-35%, respectively); protein content varied between 9 and 23%. The concentrations of the essential nutrients and moisture in cakes primarily affect the final product's characteristics [4,5] and organoleptic qualities [6].

As the temperature increased within the range of 20–30°C, water activity increased additionally. The partial evaporation of crystalline water at higher temperatures and the saturation of the solution with low-molecular components with lower values of a_w (30°C) in comparison to water activity measured at 20°C might both explain such an inverse effect. Greater volumes of water are absorbed at higher temperatures and a constant value of aw. The fruit cake products separated out from the other product samples both in terms of moisture level and saccharide content. In addition to showing values of aw decreasing with rising temperature, a sample of cereals and fruit-filled cakes also had more moisture than the other samples.

Fruit cake may include more simple saccharides as a result of its different water activity behaviour as a result of rising temperature [7]. Other cakes even had sugar crystals that could be seen on their surface, and at 30°C they may have grown more hygroscopic than they had been at 20°C. The findings imply that the moisture level of the finished product may be the only factor influencing how cakes respond to temperature. In actuality, multi-parameter complicated empirical models that describe the temperature dependence of aw exist [8]. For the benefit of this investigation, it may be assumed that there is a linear relationship between aw and temperature within the temperature range of 20–30°C based on regression features acquired. A second-degree polynomial was indicated as a better suitable model for 4 samples to characterise the temperature dependence of aw by smaller standard deviation values and greater determination coefficient values as shown in the **Table 1, Figure 1, 2** and **3.**

Table 1: Water activity of cakes at different temperatures and statistical parameters of the linear regression of the temperature dependence of a_w.

Cakes	Water activity (a_w)		
	20^{0}C	**25^{0}C**	**30^{0}C**
Plain cake	0.119±0.001	0.131±0.005	0.183±0.009
Cup cake	0.179±0.002	0.181±0.002	0.195±0.005
Vanilla cake	0.121±0.001	0.125±0.003	0.137±0.006
Apple cake	0.182±0.001	0.192±0.003	0.210±0.005
Fruit cake	0.259±0.002	0.195±0.005	0.219±0.006
Honey cake	0.195±0.007	0.210±0.009	0.309±0.005
Flourless chocolate cake	0.205±0.001	0.210±0.003	0.229±0.005
Chocolate cake	0.275±0.001	0.279±0.002	0.290±0.002
Coconut cake	0.196±0.002	0.203±0.001	0.217±0.002

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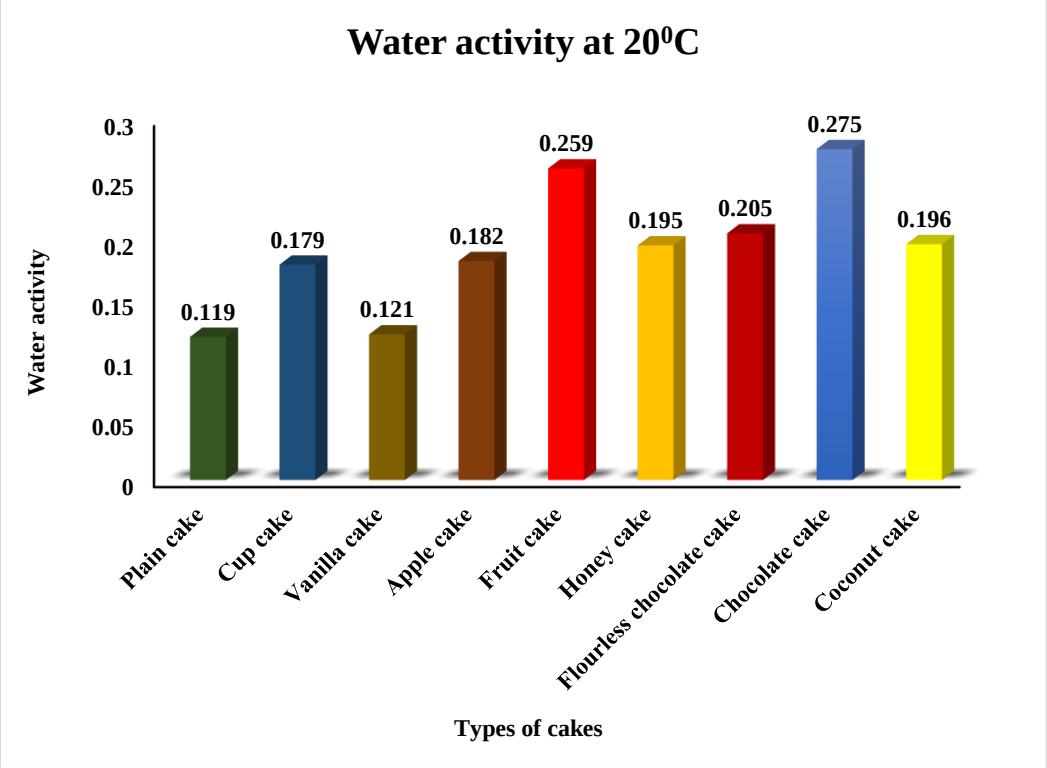

Fig.1. Determination of Water activity at 20⁰C

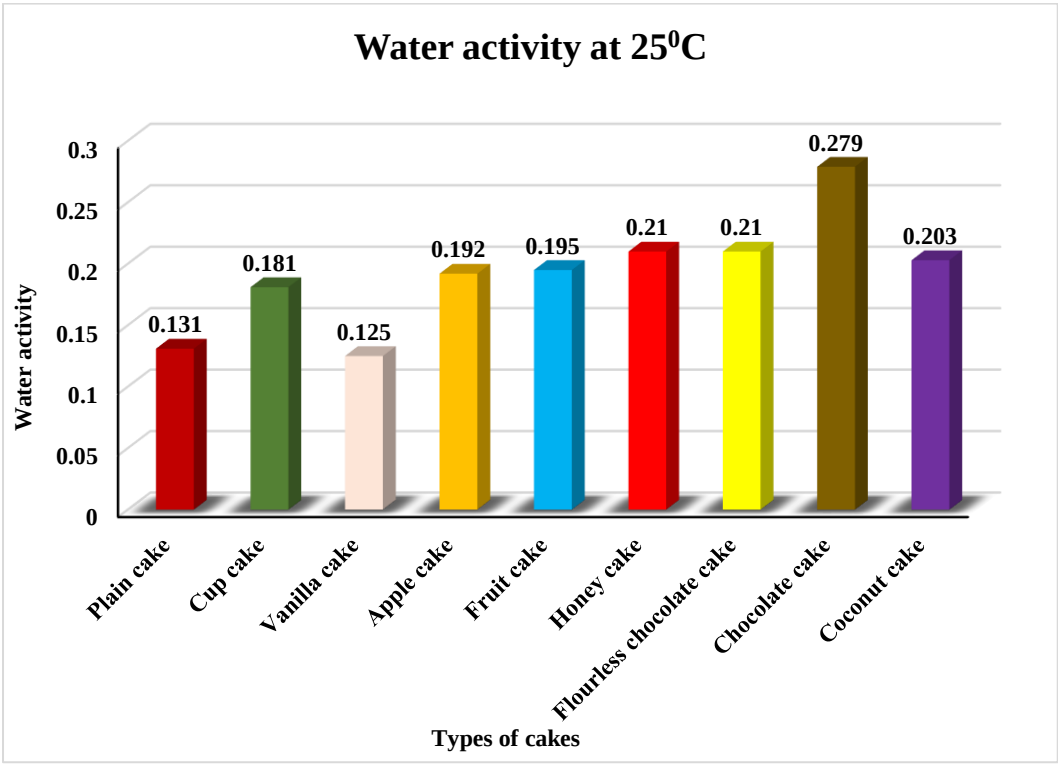

Fig.2. Determination of Water activity at 25⁰C

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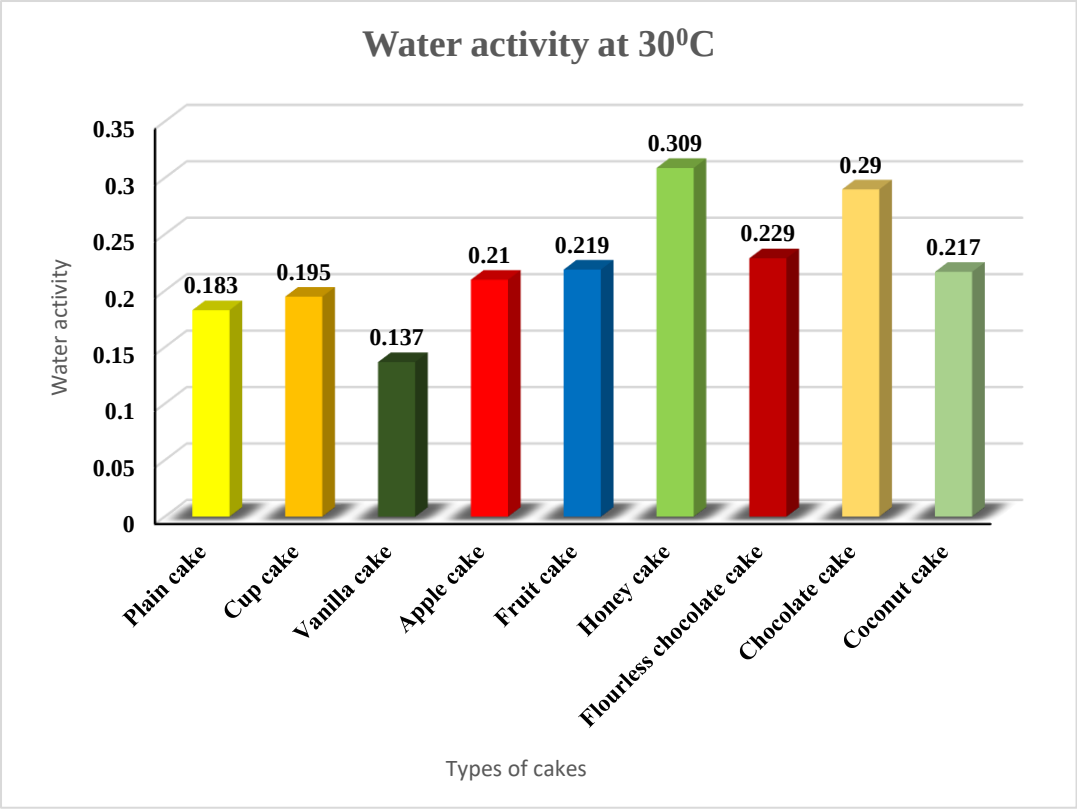

Fig.3. Determination of Water activity at 30⁰C

The document provides information on the effect of water activity and temperature on cakes. The water activity levels of the cake samples tested at various temperatures were found to range from 0.11 to 0.29. Two samples, fruit cake and chocolate cake, had higher water activity values ranging from 0.259 to 0.275. Additionally, these products had a higher moisture content of 8-9%. The moisture levels of the other cake samples varied between 4 and 6%. The concentrations of saccharides, lipids, and protein varied in the studied samples. As the temperature increased within the range of 20-30°C, water activity increased additionally. The partial evaporation of crystalline water at higher temperatures and the saturation of the solution with low-molecular components with lower values of water activity at 30°C in comparison to water activity measured at 20°C might both explain such an inverse effect. Greater volumes of water are absorbed at higher temperatures and a constant value of water activity.

4. CONCLUSION

Based on the data provided, the water activity levels of the cake samples tested at various temperatures ranged from 0.11 to 0.29. Fruit cake and chocolate cake had higher water activity values, indicating a higher moisture content of 8-9%. The other cake samples had moisture levels between 4 and 6%. The concentrations of saccharides, lipids, and protein varied among the studied samples. As the temperature increased within the range of 20-30°C, water activity also increased. This could be attributed to the partial evaporation of crystalline water at higher temperatures and the saturation of the solution with low-molecular components. Overall, the moisture content of the cakes appears to be the main factor influencing their response to temperature.

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Author contributions

Sowmya K L., collected the samples and conducted all the experiments in the Bioprocess and Fermentation Technology, Department of Studies in Microbiology, Davangere University, Davangere under the guidance of Dr. Ramalingappa. B. Professor & Dean of studies in Science & Technology who critically reviewed the study and summarised the manuscript.

FUNDING

The authors declare that there is no funding.

CONFLICT OF INTEREST

The authors declare that there is no Conflict of Interest.

DATA AVAILABILITY

The datasets generated during and/or analysed during the current study are available from the corresponding author upon reasonable request.

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