The Effects of Emulsifiers and their Different Forms on the Physical, Chemical and Textural Properties of Sponge Cakes

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Abstract

In the study, the effects of different mixture and forms of emulsifiers that play an important role in the formation of the internal structure of cakes on some quality properties of cakes were investigated. For this purpose, glycerol mono stearate (GMS) at level of 15%,30%,45% and polyglycerol ester (PGE) at level of 10%, 15%, 20% and their powder and gel mixture forms at level of 25 to 65 % were added to cake formulation.

The highest specific volume value was determined in GMS used cakes, followed by PGE, GMS/ PGE (powder) and GMS/PGE (gel). The baking lose values were lower in all of the cakes used in the emulsifier compared to the control sample. The highest and the lowest chewiness values were observed in the samples adding of 0.15 % and 0.30 % emulsifiers, respectively. The hardness value was found to be lower than that of the control sample at all levels of PGE, GMS/PGE gel and powder, while GMS was harder than the control sample at 15%. The emulsifier type and level were found to be statistically significant on the shrinkage value of cakes ($p<0.05$).

Keywords - *Sponge cake, Emulsifier, GMS, PGE*

I. INTRODUCTION

Emulsifiers are auxiliary agents that help to mix the immiscible substance with each other through their polar and nonpolar groups [1]. Today the terms "the agent that provides emulsion, surface active agent or surfactant" are also used instead of the term emulsifier. The function of emulsifier is to provide emulsion by decreasing the surface tension. The International Commission of Food Codex (CAC) describes the emulsifiers, as the agents, which are added to ensure two or more phases that, do not mix with each other such as water and fat in food [2].

Emulsifiers are classified as anionic, cationic, non-ionic, and amphoteric; as hydrophilic and lipophilic; as high and low solubility; as dust, granule, liquid and pasty in terms of their ionic loads, hydrophilic-lipophilic balance (HLB), solubility, forms, respectively [3]¬[5]. They are preferred in the food industry because of their emulsifying, suspending, dissolving, complexing, moisturizing, stabilizing and many other properties [6].

It is known that the emulsifiers are used in sponge cakes have such positive effects as proper ventilation, homogenous pore formation, delaying staling and increasing the efficiency of fat. It should be emphasized that the emulsifiers do not crystallize with water, high hydrophobic property, polar interaction with water and high molecular weight in order to have these characteristics [7].

Mono and di glycerides are synthesized by esterification of glycerin with fatty acids synthetically [8]. Mono glyceride is formed by the reaction with glycerin by a fatty acid chains while the di glyceride by two fatty acids, and they are generally used as non-ionic emulsifiers. Mono glyceride slowdowns the swelling of the starch by complexing with the amylose fraction of the starch. Mono and di glycerides improve the ability of the proofing and emulsify, promote the improvement of the internal structure, texture and symmetry of the cake and enable for the production of bulkier cakes [9].

Glycerol mono stearate ($C_{21}H_{42}O_4$), white, odorless, sweet and hygroscopic, is the glycerol ester of stearic acid [10] and it is in fatty foods. It also appears as a natural by-product during fat burning in the body. It is used as a thickener, emulsifier, anti-aggregation and preservative in food industry.

Polyglycerol ester, another emulsifier, is obtained by adding glycerol into the glycerol and fatty acid. It has a wide hydrophilic-lipophilic balance (HLB), and provides a good non-ionic surface formation, and can be dissolved in water, ethanol, and fats that have high temperature. It is durable against acids, high temperatures and hydrolysis. The daily intake amount is 25 mg/kg body weight although it is not toxic. It is used in order to improve the volume and texture, increase the dough stability and extend the shelf-life in cake production [9].

This study aims to investigate the effects of different mixture and forms of emulsifiers that play an important role in the formation of the internal structure of cakes on some quality properties of cakes. For this purpose, glycerol mono stearate (Dimodan HP) and polyglycerol ester (Grindsted PGE 55)

emulsifiers and their powder and gel mixture forms were used in cake production.

II. MATERIALS AND METHODS

A. Materials

Some products that were obtained from various companies were used in the production of cakes. These products and the companies are as follows; flour (Al-San Food Company), sunflower seed oil (BESLER), liquid margarine (Unilever-Turkey), sodium acid pyrophosphate (Prayon S.A. Belgium), sodium bicarbonate, citric acid anhydride, sorbitol, xanthan gum, whey powder, glycerol, potassium sorbate (IFC Flavor Chemistry Food In.Trade.Co., Istanbul), fructose syrup, starch (Omat Food In. and Trade Co.Ltd., Turkey), glycerol mono stearate (Dimodan HP 85) and polyglycerol ester (Grinsted PGE 55).

B. Methods

1) Cake preparation: Two different mixtures that are cake dough and non-dough were obtained during the cake production process. The mixtures obtained were mixed in another container, and the cake dough of 1000±30g was prepared. The flow diagram for the preparation of the cake dough were given in the Fig 1. Glycerol mono stearate (GMS) and polyglycerol ester (PGE) were used both separately and as a mixture in the forms of both powder and gel. GMS and PGE were added into the cake dough at the levels of 0.15, 0.30 and 0.45% and 0.10, 0.15 and 0.20%, respectively. On the other hand, GMS/PGE mixture was added into the dough at the levels of 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60 and 0.65 %.

The oven (Unox Bakertop, Italy) was set to 160°C after the cake dough was prepared. The cake dough was filled in the molds at an amount of 43-44 g. Then, they were placed into the oven that was heated previously, and were kept for 6 minutes. Afterwards, the temperature was increased up to 170 °C at which degree they were baked 6 more minutes. Finally, the temperature was decreased up to 165 °C and the baking process was ended after the cakes were baked for 6 more minutes. Then, the cakes were cooled up to room temperature.

2) Physical and Chemical Analyses: The shrinkage value was performed according to the method AACC 10-90 [11]. Firstly, the diameter of the cake mold was measured (85mm). Base diameters of cakes were measured after baked cakes were cooled up to the room temperature. In order to calculate the shrinkage value, the base diameter of the cooled cake was subtracted from the base diameter of the mold:

SV= the diameter of the cake mold (mm) – the base diameter of the cake (mm)

The specific volume was determined by proportion of the cake volume to the cake weight [12]. The pH values of the cakes were measured by a pH meter (WTW GmbH, Weilheim, Germany) after 10 g cake sample was mixed in 100 ml distilled water. The value of baking loss was calculated by dividing the weight of the cakes after reaching the room to the initial weight (42 g) of the dough. The losses at mentioned weight was calculated by the obtained value was multiplied by 100 and the value was subtracted from 100 in order to find the loss value in 100 g [13]. The determination of moisture was carried out according to Reference [14]. For this purpose, the cakes that were taken out of the oven were kept up to the room temperature, and then the measurement was carried out. In order to determine the water activity, a Pre Aqua Lab water activity device was used. The samples were placed into cell of the device and the measurement was carried out at room temperature.

Cake color was evaluated by measuring L* (brightness, 100 =white; 0 = black), a* (+, red; −, green) and b* (+, yellow; −, blue) parameters by means of a reflectance colorimeter (CR200 Chroma-meter, Minolta, Japan). For the L_0, a_0 and b_0 values of the device, the reference values obtained from barium sulphate (BaSO4) are 86.5, 2.3 and 7, respectively. The change in color ΔE were calculated based on this reference by the following formula:

$$\Delta E = [(L_0 - L)^2 + (a_0 - a)^2 + (b_0 - b)^2]^{1/2}$$

3) Texture Analysis: Cake samples were cut into pieces of 25mm×25mm×25mm dimensions, and their hardness, chewiness and resilience values were measured by Texture Profile Analyzer (TPA, Brookfield CT3) after the cakes were cooled up to the room temperature. TA25/1000 probe pressed as much as 25 % of the cake height with a 5 g of initial load in descent and ascend speed of 1 mm/s. The hardness, chewiness and resilience values were obtained from obtained graph.

4) Statistical Analysis: The study was set up and carried out according to the Test of Completely Randomized Design. The data were analyzed by SPSS and the differences between the means were determined by Tukey multiple comparison test.

III.RESULT & DISCUSSION

The means of aw, moisture, shrinkage value, baking loss, pH, specific volume, crumb and inner color values of the cakes that were produced by using the emulsifiers in different types, proportions and forms were shown in Table 1. The highest and the lowest water activity values were measured in the cakes added GMS of 0.15% and GMS/PGE (granule) of 0.60%, respectively. The aw values of the all cakes adding emulsifiers were higher than the control sample. This can be explained that the molecular weight of the emulsifiers is higher than that of the glycerol used in the cake. In the other study, it was explained that propylene glycol has a lower molecular weight than those of the glycerol, sorbitol and

maltitol, which reduced the water activity through increasing the osmotic pressure [15]. Similarly, the moisture content of the all cakes that emulsifier was added was higher than that of the control sample. The similar results were also obtained in the other studies [16]. Reference [17] stated that the increase in the moisture content leads to softer products, but they also found that some samples with lower moisture content were softer and had less resilience value than the ones with higher moisture content. For this reason, they emphasized that water alone does not have any effect on the hardness or the resilience, and the mixing and kneading during the production can also be effective on these values.

When the shrinkage values were examined, it was determined that the shrinkage values also increased as the proportion of the GMS increased in the cakes. On the other hand, it was observed that the shrinkage value in the PGE adding cakes increased until the level of 0.15%, and a decrease was observed in above this level. The shrinkage value of the samples that have GMS/PGE (powder) level of 0.40% was higher than that of the control sample, but, the shrinkage value in all proportions above that level (except 0.55 %) was lower than that of the control sample. The shrinkage values were found higher than that of the control sample except the cakes which 0.45 % and 0.65 % GMS/PGE (gel) was added. Reference [2] found that cakes had lower shrinkage values although some samples which added emulsifier were of less volume than others, and it was expressed that the volumetric reduction in the cake can result from the cake shrinks vertically due to outgassing from the tiny fractures on the upper surface of the cake, as a result of which, thus leading to less shrinkage on the sides.

Reference [18] determined the qualities of the cakes containing emulsifiers and xanthan gum without eggs, and found that the xanthan decreased the shrinkage while increasing the cake's proof. In other study, it was found that the usage of some hydrocolloids and the emulsifiers (Glycerol mono stearate, Sodium stearol-2-lactilat) led to a synergistic effect [19]. It is thought that the decrease in the shrinkage value of the samples resulted from the emulsifiers and the synergistic effect of the xanthan gum that was involved in the cake formula along with the emulsifiers.

The baking loss values in the cakes which emulsifiers were added were lower than that of control. In the research carried out by Reference [20], they established that higher protein of wheat flour helps the reduction in baking loss and also that the cakes with xanthan gum has the lowest level of baking loss. Thus, they stated that binding capacity of the proteins and hydrocolloids increases with water, which may contribute to the changes in baking loss by percentage (%). Therefore, it can be said that the water-holding characteristic of emulsifiers helps to reduce the loss of cooking by contributing to the binding capacity.

It was determined that the sample with 0.15 % PGE had the lowest pH value (6.12), while the sample with 0.65 % GMS/PGE (gel) had the highest pH value (6.77). If the cake has a lower pH value, the upper surface of cake always collapses and its internal structure is soft as cotton. It is desirable to have the pH as high as possible as the upper middle surface of the cake is desired to be puffy [16]. It was found that the pH value of all cakes increases with emulsifiers adding and this is a desirable situation for the volume of cakes.

The value of specific volume in the cakes with GMS was found to be higher than the control sample and it was detected that the value increased as the level of emulsifiers increased. Similar results were obtained in other studies [2], [21], [22]. The specific volume values were measured as 0.1%, 0.25% and 0.55% in the cakes adding PGE, GMS/PGE (powder) and GMS/PGE (gel), respectively. In the other study, the Polysorbate 60, Sodium stearoyl-2-lactylate, distilled glycerol mono stearate, propylene glycol mono stearate and sorbitan mono stearate as emulsifiers were added to cakes, and it was found that the use of emulsifiers increased the value of specific volume [23]. In the same study, the specific volume values of some levels of emulsifier mixtures were lower than that of control sample. In other words, it is understood that the use of emulsifiers in mixture form can variation while it is possible to produce cakes with higher specific volume values by using emulsifier.

When the results regarding crust and internal colors were analyzed, it was determined that the color of the control sample was darker and both the crust and internal color became lighter with the use of emulsifiers. Similar results were obtained in other studies [16], [21]. Reference [21] also found that the dark color of the samples without emulsifiers might result from the temperature and baking time, and they thought that the color of control sample was lighter and the darkest red color due to the maillard reaction. The means of chewiness, hardness and resilience values for the cakes produced by using emulsifiers in different type, level and forms were given in Table 2.

Table 1. Tukey comparison test results of mean scores for the a_w, moisture, shrinkage value, baking loss, pH, specific volume, crust and internal color values of the cakes that were produced by using the emulsifiers GMS, PGE, GMS/PGE (powder), GMS/PGE (gel) in different proportions

Emulsifier	Proportion	a_w	Moisture	Shrinkage value	Baking loss	pH	Specific volume	Crust color	Internal color
Control		0.643 ± 0.001^{a}	10.21 ± 0.02^{a}	5.93 ± 0.03^{a}	16.57 ± 0.04^{a}	5.97 ± 0.03^{a}	0.96 ± 0.00	50.11 ± 0.01^{a}	77.58 ± 0.03^{a}
GMS	0.15	0.742 ± 0.001^{d}	16.18 ± 0.04^{c}	5.87 ± 0.04^{a}	9.81 ± 0.11^{d}	6.20 ± 0.01^{b}	0.99 ± 0.01	66.40 ± 0.04^{d}	80.77 ± 0.06^{c}
	0.30	0.720 ± 0.001^{c}	16.21 ± 0.75^{c}	6.07 ± 0.03^{b}	13.78 ± 0.04^{c}	6.41 ± 0.06^{c}	1.00 ± 0.003	62.76 ± 0.07^{c}	79.86 ± 0.07^{b}
	0.45	0.716 ± 0.001^{b}	14.93 ± 0.01^{b}	6.41 ± 0.01^{c}	11.66 ± 0.06^{b}	6.47 ± 0.04^{c}	1.03 ± 0.04	56.18 ± 0.03^{b}	81.85 ± 0.07^{d}
PGE	0.10	0.725 ± 0.000^{b}	14.73 ± 0.01^{c}	6.11 ± 0.06^{c}	12.94 ± 0.03^{c}	6.46 ± 0.03^{c}	1.02 ± 0.01	62.07 ± 0.01^{b}	81.36 ± 0.04^{c}
	0.15	0.726 ± 0.001^{b}	13.22 ± 0.02^{b}	6.56 ± 0.03^{d}	12.74 ± 0.04^{b}	6.12 ± 0.01^{b}	0.96 ± 0.03	64.08 ± 0.06^{c}	82.26 ± 0.04^{d}
	0.20	0.740 ± 0.017^{b}	14.73 ± 0.03^{c}	5.61 ± 0.03^{a}	8.12 ± 0.06^{a}	6.14 ± 0.01^{b}	0.97 ± 0.03	69.15 ± 0.03^{d}	80.97 ± 0.01^{b}
GMS/PGE (powder)	0.25	0.713 ± 0.001^{h}	15.19 ± 0.01^{h}	6.84 ± 0.04^{d}	13.34 ± 0.07^{g}	6.21 ± 0.04^{b}	0.98 ± 0.04	68.53 ± 0.01^{i}	81.14 ± 0.03^{d}
	0.30	0.670 ± 0.001^{c}	14.41 ± 0.00^{f}	6.26 ± 0.04^{c}	10.55 ± 0.06^{c}	6.59 ± 0.03^{h}	0.96 ± 0.03	63.68 ± 0.04^{e}	81.64 ± 0.03^{e}
	0.35	0.729 ± 0.001^{i}	15.10 ± 0.04^{g}	6.86 ± 0.01^{d}	11.68 ± 0.04^{e}	6.37 ± 0.07^{de}	0.94 ± 0.01	65.56 ± 0.01^{h}	81.02 ± 0.04^{c}
	0.40	0.696 ± 0.001^{e}	14.36 ± 0.01^{e}	5.88 ± 0.68^{bc}	10.58 ± 0.09^{cd}	6.42 ± 0.06^{def}	0.95 ± 0.04	62.54 ± 0.06^{d}	81.91 ± 0.06^{f}
	0.45	0.706 ± 0.001^{f}	14.39 ± 0.01^{ef}	5.90 ± 0.06^{bc}	11.71 ± 0.09^{e}	6.27 ± 0.01^{bc}	0.92 ± 0.03	62.35 ± 0.06^{c}	83.10 ± 0.07^{g}
	0.50	0.693 ± 0.001^{d}	13.62 ± 0.01^{c}	5.52 ± 0.03^{b}	10.70 ± 0.04^{d}	6.48 ± 0.04^{fg}	0.96 ± 0.01	64.05 ± 0.09^{f}	81.83 ± 0.06^{f}
	0.55	0.741 ± 0.001^{j}	15.18 ± 0.01^{h}	7.56 ± 0.01^{e}	7.25 ± 0.06^{a}	6.46 ± 0.03^{efg}	0.97 ± 0.03	63.77 ± 0.03^{e}	80.05 ± 0.01^{b}
	0.60	0.660 ± 0.001^{b}	13.40 ± 0.01^{b}	4.78 ± 0.04^{a}	12.27 ± 0.07^{f}	6.54 ± 0.03^{gh}	0.94 ± 0.04	65.41 ± 0.06^{g}	81.88 ± 0.06^{f}
	0.65	0.711 ± 0.001^{g}	14.15 ± 0.01^{d}	4.98 ± 0.03^{a}	10.32 ± 0.06^{b}	6.35 ± 0.04^{cd}	0.95 ± 0.00	61.48 ± 0.07^{b}	81.70 ± 0.01^{e}
GMS/PGE (gel)	0.25	0.711 ± 0.000^{f}	13.77 ± 0.01^{d}	6.42 ± 0.04^{de}	11.63 ± 0.03^{d}	6.34 ± 0.06^{c}	0.99 ± 0.01^{cd}	60.45 ± 0.06^{d}	79.84 ± 0.07^{b}
	0.30	0.710 ± 0.001^{ef}	13.39 ± 0.01^{d}	7.39 ± 0.04^{h}	13.66 ± 0.01^{g}	6.35 ± 0.04^{c}	0.91 ± 0.01^{a}	63.22 ± 0.03^{e}	83.42 ± 0.11^{e}
	0.35	0.705 ± 0.001^{c}	13.89 ± 0.01^{d}	7.15 ± 0.01^{g}	11.46 ± 0.04^{c}	6.39 ± 0.03^{c}	0.93 ± 0.00^{ab}	60.44 ± 0.03^{d}	83.51 ± 0.13^{e}
	0.40	0.707 ± 0.000^{d}	12.82 ± 0.06^{c}	7.65 ± 0.06^{i}	9.20 ± 0.03^{a}	6.58 ± 0.06^{d}	$0.99\pm0.03c^{d}$	59.69 ± 0.06^{c}	80.51 ± 0.14^{c}
	0.45	0.729 ± 0.001^{g}	15.69 ± 0.76^{f}	5.66 ± 0.03^{b}	13.73 ± 0.01^{h}	6.44 ± 0.07^{c}	1.00 ± 0.00^{cd}	68.43 ± 0.04^{h}	80.14 ± 0.23^{b}
	0.50	0.732 ± 0.001^{h}	14.57 ± 0.10^{e}	6.49 ± 0.01^{e}	11.94 ± 0.04^{e}	6.13 ± 0.04^{b}	0.93 ± 0.04^{ab}	66.25 ± 0.04^{g}	83.76 ± 0.20^{e}
	0.55	0.675 ± 0.001^{b}	12.19 ± 0.02^{b}	6.77 ± 0.03^{f}	13.51 ± 0.07^{f}	6.56 ± 0.06^{d}	1.05 ± 0.01^{e}	53.67 ± 0.03^{b}	77.67 ± 0.20^{a}
	0.60	0.709 ± 0.001^{e}	13.64 ± 0.01^{d}	6.40 ± 0.04^{d}	9.97 ± 0.06^{b}	6.38 ± 0.01^{c}	0.97 ± 0.00^{bcd}	59.68 ± 0.07^{c}	80.10 ± 0.14^{b}
	0.65	0.708 ± 0.000^{de}	13.81 ± 0.01^{d}	5.31 ± 0.06^{a}	13.45 ± 0.09^{f}	6.77 ± 0.03^{e}	1.01 ± 0.01^{de}	64.25 ± 0.01^{f}	81.69 ± 0.16^{d}

The mean scores of the same variable that were highlighted with different letters are statistically different form one another ($p<0.05$), ± standard deviation

The chewiness value of cakes with GMS/PGE (powder) except added of 0.25% and 0.60% emulsifiers was lower than that of the control sample. Similarly, Reference [24] were reported that the cakes with emulsifiers had lower hardness and cakes with emulsifiers had lower hardness and chewiness values than that of the control sample. In the other study, it was determined that consumers preferred the cakes which are soft, resilient, sticky and easy to chew and the samples with emulsifiers had a better chewiness value although they were less resilient and sticky [22].

Analyzing the hardness values, it was determined that hardness value of the cakes with a level GMS of 0.15% was higher than that of the control sample but the hardness value decreased according to the control sample as the amount of emulsifiers increased. On the other hand, it was found that the hardness value decreased as the use of emulsifiers increased in cakes with PGE, and the hardness values of all samples with emulsifiers were lower than that of the control sample. The similar results were also obtained in other studies [16].

It was observed that the hardness values of all the cakes with GMS/PGE (gel) was lower according to the control sample while the hardness values in the cakes with GMS/PGE (powder) were lower in all cakes than that of the control sample except the level of 0.60%. In other study, it was observed that the hardness values of the cakes with emulsifiers decreased rapidly (Fu et al., 2018). Reference [25] found that the hardness value in the cakes with level of 0.25% GMS was much higher than that of the control sample but the hardness value in the cakes with level of 0.75% GMS was close to the control sample. In another study, a relationship was determined between the chewiness and hardness [21].

It was found that the resilience values of all the cakes with emulsifier were higher than that of the control sample. Reference [26] stated that the intense cakes including less gas cell turns to the original shape takes more time after applying pressure, and this reduced the resilience value. Thus, it is estimated that the resilience value was higher according to the control value due to more gas cells and homogeneous in the cakes with emulsifiers. Similarly, Reference [27] determined that the resilience values increased in all cakes with emulsifiers.

Table 2. Tukey comparison test results of mean scores for chewiness, hardness and resilience values of the cakes that were produced by using emulsifiers GMS, PGE, GMS/PGE (powder), GMS/PGE (gel) in different proportions

Emulsifier	Proportion	Chewiness	Hardness	Resilience
Control	0.00	161.81±0.59^{a}	2873.50±2.12	0.16±0.00^{a}
GMS	0.15	192.13±1.24^{c}	2933.00±0.00	0.19±0.01^{b}
	0.30	161.86±0.20^{a}	2598.00±2.83	0.19±0.00^{b}
	0.45	173.06±1.13^{b}	2781.00±2.51	0.17±0.01^{a}
PGE	0.10	132.93±0.90^{c}	2298.50±0.71^{c}	0.22±0.01^{b}
	0.15	108.00±0.04^{b}	2000.00±1.41^{b}	0.21±0.00^{b}
	0.20	69.66±0.42^{a}	1244.00±0.00^{a}	0.22±0.01^{b}
GMS/PGE (powder)	0.25	177.36±0.51^{i}	2858.50±0.71^{h}	0.19±0.01^{de}
	0.30	106.02±0.02^{b}	1990.75±1.06^{c}	0.18±0.00^{cd}
	0.35	143.51±0.74^{g}	2345.00±0.00^{f}	0.19±0.01^{de}
	0.40	104.05±1.06^{a}	1905.50±0.71^{a}	0.20±0.01^{e}
	0.45	111.12±1.25^{d}	2072.25±0.35^{d}	0.18±0.00^{cd}
	0.50	115.02±0.03^{e}	2139.00±0.71^{e}	0.19±0.01^{de}
	0.55	107.58±0.60^{c}	1977.25±1.06^{b}	0.17±0.00^{bc}
	0.60	189.93±0.21^{j}	3335.75±0.35^{j}	0.16±0.01^{a}
	0.65	124.39±0.40^{f}	2502.75±0.35^{g}	0.16±0.00^{ab}
GMS/PGE (gel)	0.25	75.82±0.21^{c}	1466.75±0.35	0.20±0.00^{e}
	0.30	69.84±0.25^{b}	1569.00±0.00	0.19±0.01^{b}
	0.35	66.29±0.38^{a}	1419.25±1.06	0.20±0.00^{e}
	0.40	90.53±0.82^{g}	2060.00±6.36	0.18±0.00^{b}
	0.45	147.04±0.08^{i}	2259.50±1.27	0.19±0.00^{cd}
	0.50	81.10±0.02^{d}	1761.00±1.41	0.20±0.01^{de}
	0.55	87.41±0.02^{f}	2136.50±0.00	0.17±0.01^{a}
	0.60	84.78±0.15^{e}	1898.75±0.35	0.19±0.00^{cd}
	0.65	93.21±0.09^{h}	2163.00±0.71	0.18±0.00^{b}

The mean scores of the same variable that were highlighted with different letters are statistically different form one another ($p<0.05$), ± standard deviation

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