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#### ■ Keywords

Commercial Table eggs; Marketing channels; Season; Egg quality; Table egg classification.



## **Effects of Marketing Channels and Season on Weight and Quality Grades Classification According to Gulf Cooperation Council Standardization Organization standard of Fresh Commercial Table Eggs Marketed in Riyadh City (Saudi Arabia)**

### **ABSTRACT**

The present study aimed to assess egg quality by identifying quality grades and weight class classification of fresh commercial Table eggs marketed in the city of Riyadh during winter and the summer seasons, and comparing the measured traits rendering to the Gulf Cooperation Council Standardization Organization. A total of 480 eggs were purchased from two different channels of marketing, four supermarkets and four grocery stores located in different areas of the city of Riyadh during summer and the winter seasons. It appeared from the outcomes that the eggs purchased from the supermarkets had significantly higher AA and A Haugh units, albumin pH and AA air cell grades and medium egg weight class, and they also had lower B and C Haugh units, albumen pH, A and B air cell depth grades, and very large, large and small eggs weight classes percentages than those obtained from grocery stores. Over and above, the eggs obtained in the winter had significantly higher AA and A Haugh unit, albumin pH, AA air cell depth grades percentages, very large and large egg weight class percentages, and had less B and C Haugh unit and albumen pH and B air cell depth grades and small weight class percentages than those obtained in the summer. In summary, marketing channels and season play a significant role in affecting quality traits of Table eggs, also those procured from supermarkets and in the winter presented better quality than those obtained from groceries or in the summer, respectively. Grocery stores or small shops have to follow proper handling and storage conditions requirements to maintain good quality of Table eggs, especially in the summer season.

### **INTRODUCTION**

Chicken's eggs are a rich source of essential amino acids, lipids, minerals, and vitamins, therefore considered by W.H.O as a reference protein source for children, which is slightly higher than breast milk (Nys & Sauveur 2004).

Eggs produced in farms could have good quality, but weak handling and storage conditions on farms or in marketing channels could lead to losses in egg quality (Al-Obaidi *et al.* 2011). The first change, which takes place in the egg is the loss of weight due to evaporation of moisture and loss of gases, suchlike carbon dioxide (Harpreet *et al.* 1993). The changes in egg quality parameters, such as Haugh units, albumen height, albumen and yolk pH, yolk and albumin weight and air cell depth, are due to moisture loss by evaporation through the shell pores and escape of CO<sub>2</sub> (Carter 1968; Walsh *et al.* 1995).

Under UNECE Standard EGG-1 (UNECE2010) enforced in all European Union Countries, eggs are classed as either class A or B eggs, and only eggs graded class A can be sold for direct human consumption or retailed. Regarding to USDA egg grading manual (USDA 2000), eggs have three grades based on the interior quality and condition



and appearance of the eggshell, grade AA and A eggs are usually retailed, while grade B eggs are usually sent for further processing. According to Arab Gulf Cooperation Council Standardization Organization, eggs are graded to four classes AA, A, B and C, based on the interior quality and condition and appearance of the eggshell and only AA, A, and B grades can be sold for direct human consumption or retailed, but grade C can be used in food processing. GCC also requires that eggs should be classified by weight into five grades: 1 to 5 as, Grade 1 (very large) 70 grams and more, Grade 2 (large) from 60 to less than 70 grams, Grade 3 (moderate) from 50 to less than 60 grams, Grade 4 (small) from 40 to less than 50 grams and Grade 5 (very small) less than 40 grams, and all those classifications shall be written on the package (GSO 2014).

Since 1980, the production and consumption of Table eggs in Saudi Arabia has witnessed a dramatic and continuous increase. Annual egg production increased from 3 billion in 2007 to 5 billion eggs in 2017, and per capita egg consumption increased at the same period from 142 to 158 eggs respectively (GASTAT2017). In Saudi Arabia, commercial Table eggs are mainly marketed in supermarkets, poultry shops and grocery stores. In general, Saudi families purchase eggs by tray, which contains 30 eggs, store it in the refrigerator and consume it within one to two weeks. However, very sparse information is available regarding quality characteristics of locally produced commercial eggs.

The present study aimed to assess egg quality by identifying the quality grades and weight classes percentages of fresh commercial Table eggs marketed in the city of Riyadh during winter and the summer season, according to the Gulf Cooperation Council Standardization Organization's requirements.

## MATERIALS AND METHODS

### Sample Procedure

A total of 480 eggs were acquired from two different marketing channels, four supermarkets and four grocery shops in different locations (North East, North West, South East and South West) in Riyadh city. Ten eggs were collected from each marketing channel/month during summer (July, August and September, 2019) and winter (December, January and February, 2020) seasons. The eggs were then numbered individually, checked for cleanness, soundness, and weighed to 0.1 gram. Air cell depth (AC) was measured in millimeter by using candling light and a thin plastic ruler, while Haugh unit values

were directly estimated using a micrometer adjustable to egg weight, (Haugh 1937) and albumen and yolk pH were measured immediately using a calibrated pH meter (H12212 pH Meter, HANA instruments). Egg quality and weight grades were classified according to the G.C.C Standardization Organization (GSO 2014).

### Data analysis

The data obtained from the current study were subjected to statistical analysis two-way ANOVA2\*2 using the General Linear Models procedures of SAS Institute (SAS 2008) according to the following model,

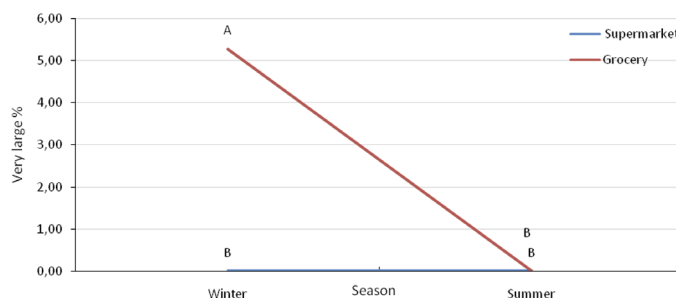
$$Y_{ijkl} = \mu + C_i + S_j + (CS)_{ij} + \epsilon_{ijkl}$$

Where,  $Y_{ij}$  is the  $l$ th observation of the  $i$ th marketing channels  $j$ th season and  $k$ th storage period,  $\mu$  overall mean,  $C_i$  effect of marketing channel (Supermarket and grocery),  $S_j$  effect of season (winter and season),  $CS_{ij}$  interaction effect between marketing channel and season, and  $\epsilon_{ij}$  experimental error. Means statistical differences were tested using the least significant differences (LSD) procedure.

## RESULTS

### Egg Weight Classes Percentages (EWCP)

The results in Table 1 displays that marketing channels, season and their interaction had a significant ( $p \leq 0.05$ ) effect on all EWCP of commercial eggs marketed in Riyadh city. Nonetheless moderate EWCP were not affected by the season. Egg purchased from groceries had significantly ( $p \leq 0.05$ ) the upper most very large, large and small EWCP than those procured from supermarkets, while eggs bought from supermarkets had significantly ( $p \leq 0.05$ ) higher moderate EWCP than those acquired from grocery stores (Table 1). The same table also displays that eggs obtained in the winter had significantly ( $p \leq 0.05$ ) higher very large, large, lower small and similar moderate EWCP compared with those bought from grocery stores in the summer. Figure 1 reveals that eggs purchased from



**Figure 1** – The interaction effect of season and marketing channel on egg weight grades percentages.

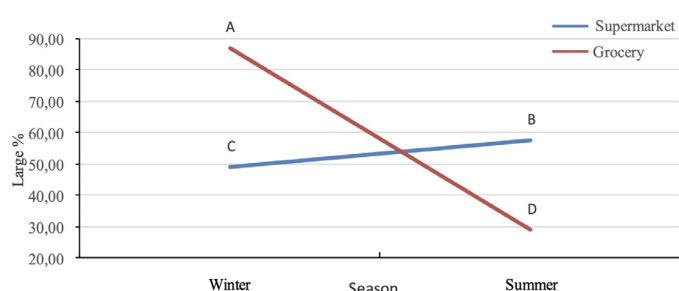


**Table 1** – Effect of marketing channel and season on egg weight grades percentages \* of Table eggs marketed in Riyadh city.

		Weight grades percentages			
		Very large	Large	Moderate	Small
Marketing channel	Supermarket	0.00 <sup>b</sup>	53.19 <sup>b</sup>	28.61 <sup>a</sup>	18.19 <sup>b</sup>
	Grocery	2.64 <sup>a</sup>	57.92 <sup>a</sup>	14.03 <sup>b</sup>	25.42 <sup>a</sup>
	SEM	0.420±	1.793±	1.503±	1.459±
Season	Winter	2.64 <sup>a</sup>	67.92 <sup>a</sup>	20.42 <sup>a</sup>	9.03 <sup>b</sup>
	Summer	0.00 <sup>b</sup>	43.19 <sup>b</sup>	22.22 <sup>a</sup>	34.58 <sup>a</sup>
	SEM	0.420±	1.793±	1.503±	1.459±
p-value	Mean	1.32	55.56	21.32	21.81
	SEM	0.301	1.310	1.080	1.089
	C	0.0001	0.0474	0.0001	0.0004
	S	0.0001	0.0001	0.3798	0.0001
	C*S	0.0001	0.0001	0.0001	0.0001

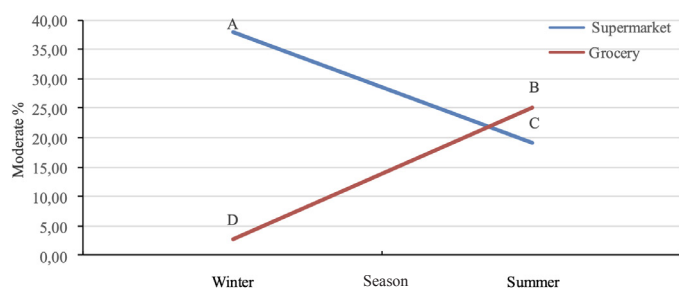
GSO grading\*. SEM: standard error of means. Very large; 70 g <; large: 60 to 70 g; Moderate: 50 to 60 g; Small: 40 to 50 g. <sup>a,c</sup>Values in the same column with same factor, with different superscript letters differ significantly ( $p \leq 0.05$ ).

grocery stores in the winter had significantly ( $p \leq 0.05$ ) the highest very large EWCP, whereas those purchased from groceries in the summer and from supermarkets in the winter had statistically similar EWCP values. Figure 2 designates that eggs acquired from grocery stores in the winter and summer had statistically ( $p \leq 0.05$ ), the highest and lowest large EWCP, respectively, while



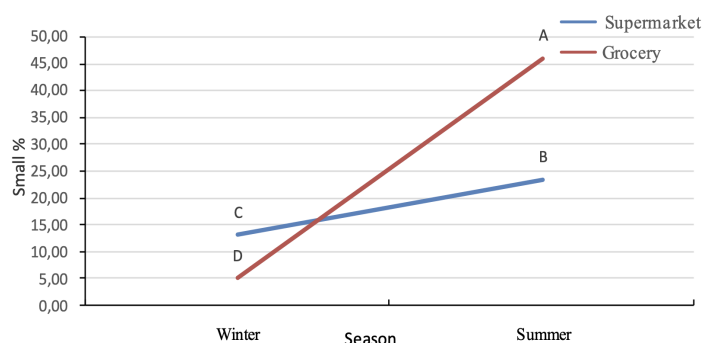
**Figure 2** – The interaction effect of season and marketing channel on egg weight grades percentages.

eggs obtained from supermarkets in the summer had statistically ( $p \leq 0.05$ ) the uppermost large EWCP than those purchased in the winter. Figure 3 points out that eggs bought from supermarkets and grocery stores in the winter had significantly ( $p \leq 0.05$ ) the uppermost and lowest moderate EWCP, respectively, whereas eggs obtained from grocery stores in the summer



**Figure 3** – The interaction effect of season and marketing channel on egg weight grades percentages.

had significantly higher moderate EWCP compared with their peers procured from supermarkets. Eggs purchased from grocery stores in the summer and winter had statistically ( $p \leq 0.05$ ) the highest and lowest small EWCP, respectively compared to their peer bought from supermarkets (Figure 4).



**Figure 4** – The interaction effect of season and marketing channel on egg weight grades percentages.

### Air Cell Depth Grades Percentages (ACGP)

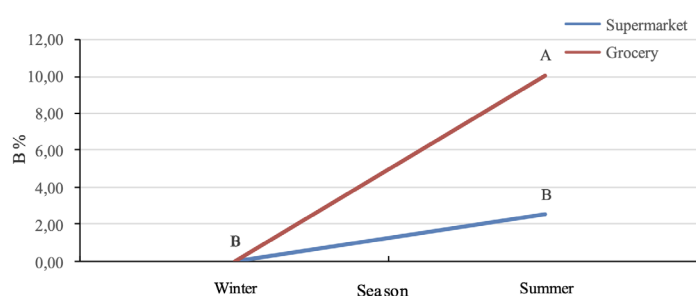
Marketing channels and season had a significant ( $p \leq 0.05$ ) effect on most ACGP, while their interaction had a significant ( $p \leq 0.05$ ) effect only on B ACGP, eggs bought from supermarkets had significantly ( $p \leq 0.05$ ) higher AA, and lower A and B ACGP than those procured from grocery stores. On the other hand, eggs obtained in the winter had significantly ( $p \leq 0.05$ ) higher AA and lower B ACGP compared to those obtained in the summer, but A ACGP was statistically similar for both seasons, while C ACGP was not affected by any of the studied factors (Table 2). Eggs procured from groceries in the summer had significantly the highest B, while eggs purchased from supermarkets in the winter had statically similar B ACGP (Figure 5).



**Table 2** – Effect of marketing channel and season on air cell depth grades percentages\* of Table eggs marketed in Riyadh city.

		Air cell depth grades percentages		
		AA	A	B
Marketing channel	Supermarket	77.50 <sup>a</sup>	21.25 <sup>b</sup>	1.25 <sup>b</sup>
	Grocery	65.83 <sup>b</sup>	29.17 <sup>a</sup>	5.00 <sup>a</sup>
	SEM	1.793±	2.799±	1.096±
Season	Winter	77.08 <sup>a</sup>	22.92 <sup>a</sup>	0.00 <sup>b</sup>
	Summer	66.25 <sup>b</sup>	27.50 <sup>a</sup>	6.25 <sup>a</sup>
	SEM	1.793±	2.799±	1.096±
p. Value	Mean	71.67	25.21	3.13
	SEM	2.059	1.984	0.795
	C	0.0043	0.0461	0.016
	S	0.0079	0.2475	<.0001
	C*S	0.3054	0.9162	0.016

GSO grading\*. SEM: standard error of means. Grades AA;  $\leq 3$ ; A:  $\leq 5$ ; B:  $\leq 9$  mm. <sup>a-c</sup>Values in the same column with same factor, with different superscript letters differ significantly ( $p \leq 0.05$ ).

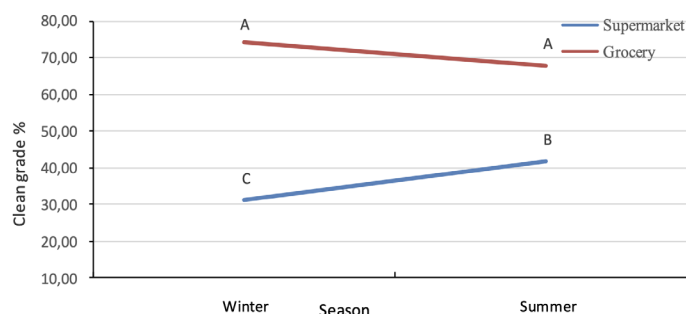


**Figure 5** – The interaction effect of season and marketing channel on air cell depth grades percentages.

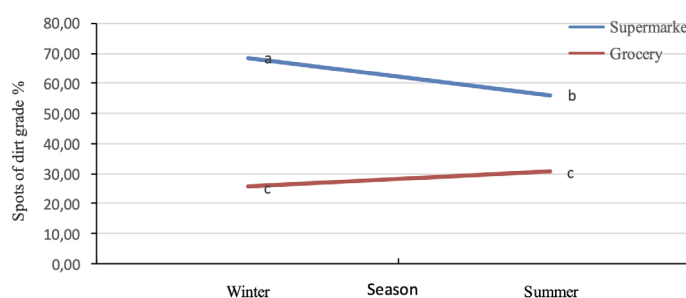
### Cleanness grades percentages (CGP)

Table 3 presents that season and the interaction between season and marketing channel had a significant ( $p \leq 0.01$ ) impact on cleanness and spots of dirt grades percentages, while dirty CGP was significantly ( $p \leq 0.05$ ) influenced only by marketing channels, eggs purchased from both channels of marketing had statistically similar cleanness and spot of dirt CGP, while eggs obtained in the summer had significantly ( $p \leq 0.05$ ) the uppermost cleanness, and lower spot of dirt CGP compared with those found in the winter (Table 3). The same table also shows that eggs obtained in the summer and winter had statistically similar dirty CGP, but eggs bought from supermarkets had a significant ( $p \leq 0.05$ ) lower dirty CGP than those acquired from grocery stores. It can be seen from Figure 6 that the eggs acquired from grocery stores in the winter and summer had statistically similar clean CGP, and had significantly ( $p \leq 0.05$ ) higher values than those purchased from supermarket stores. Besides, eggs acquired from supermarkets in the winter had significantly ( $p \leq 0.05$ ) the least clean CGP. Figure 7 shows that eggs purchased from groceries in the winter and summer

had statistically similar spot of dirt CGP, but had significantly ( $p \leq 0.05$ ) less values than their peers found in supermarket stores. The same figure also shows that eggs purchased from supermarkets in the winter had significantly higher spot of dirt CGP compared to their peers bought in the summer.



**Figure 6** – The interaction effect of season and marketing channel on cleanness grades percentages.



**Figure 7** – The interaction effect of season and marketing channel on cleanness grades percentages.

### Soundness grade percentages (SGP)

Only channels of marketing had a significant ( $p \leq 0.01$ ) effect on cracked and broken eggs, however eggs acquired from grocery stores had significantly ( $p \leq 0.05$ ) the uppermost cracked, and the lowermost broken SGP compared to those obtained from supermarkets (Table 3). The same table also displays





**Table 3** – Effect of marketing channel and season on cleanness and soundness grades percentages\* of Table eggs marketed in Riyadh city.

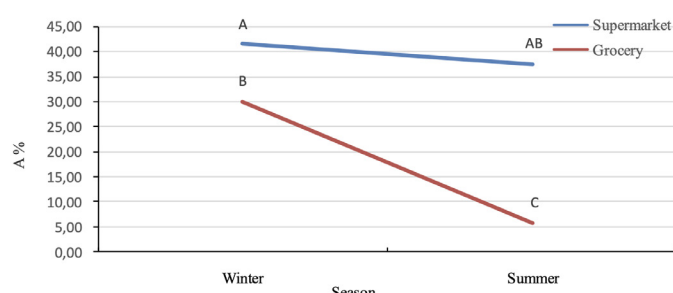
		Cleanness Grades Percentages			Soundness Grades Percentages		
		Clean	Spots	Dirty	Sound	Cracked	Broken
Marketing channel	Supermarket	52.64 <sup>a</sup>	47.22 <sup>a</sup>	0.14 <sup>b</sup>	84.72 <sup>a</sup>	10.83 <sup>b</sup>	4.44 <sup>a</sup>
	Grocery	54.72 <sup>a</sup>	43.61 <sup>a</sup>	1.67 <sup>a</sup>	83.33 <sup>a</sup>	14.44 <sup>a</sup>	2.22 <sup>b</sup>
	SEM	1.744±	0.017±	0.352±	1.365±	1.237±	0.663±
Season	Winter	36.39 <sup>b</sup>	62.64 <sup>a</sup>	0.97 <sup>a</sup>	85.56 <sup>a</sup>	13.47 <sup>a</sup>	0.97 <sup>b</sup>
	Summer	70.97 <sup>a</sup>	28.19 <sup>b</sup>	0.83 <sup>a</sup>	82.50 <sup>a</sup>	11.81 <sup>a</sup>	5.69 <sup>a</sup>
	SEM	1.744±	0.017±	0.352±	1.365±	1.237±	0.663±
p. Value	Mean	53.681	45.417	0.903	84.028	12.639	3.333
	SEM	1.314	1.313	0.249	0.966	0.876	0.473
	c	0.3968	0.1411	0.0022	0.4720	0.0393	0.0178
	S	0.0001	0.0001	0.7801	0.1137	0.3412	0.0001
	C*S	0.0006	0.0003	0.4024	0.1955	0.5257	0.1383

GSO grading\*. SEM: standard error of means. <sup>a-c</sup>Values in the same column with same factor, with different superscript letters differ significantly ( $p \leq 0.05$ ).

that eggs obtained in the summer and winter had statistically similar sound and cracked SGP, while those obtained in the summer had significantly ( $p \leq 0.05$ ) higher broken grade percentage than those acquired in the winter.

### Haugh unit values grades percentages (HUGP)

It is obvious from Table 4 that marketing channels and season had a significant ( $p \leq 0.05$ ) influence on all HUGP, whereas their interaction had significantly affected only A and C HUGP of commercial eggs marketed in Riyadh city. The eggs purchased from supermarkets or in the winter had significantly ( $p \leq 0.05$ ) higher AA and A and lower B and C HUGP than those acquired from groceries or in the summer, respectively (Table 4). It appears from figure 8 that the eggs purchased from supermarkets in the winter



**Figure 8** – The interaction effect of marketing channels and season on Haugh unit values percentages.

and summer had statistically similar grade A and the eggs obtained from grocery stores in the summer had significantly the lowest A HUGP, however the eggs obtained from grocery stores in the winter had statistically similar A HUGP as those bought from supermarkets in the summer, but significantly ( $p \leq 0.05$ ) less A HUGP than those purchased from supermarkets

**Table 4** – Effect of marketing channel and season on Haugh unit and albumin pH grades percentages\* of Table eggs marketed in Riyadh City.

		Haugh Unit Grade Percentages				Albumin pH Grade Percentages			
		AA	A	B	C	AA	A	B	C
Marketing channel	Supermarket	23.33 <sup>a</sup>	39.58 <sup>a</sup>	36.67 <sup>b</sup>	0.42 <sup>b</sup>	23.33 <sup>a</sup>	39.58 <sup>a</sup>	36.67 <sup>b</sup>	0.42 <sup>b</sup>
	Grocery	9.58 <sup>b</sup>	17.92 <sup>b</sup>	62.92 <sup>a</sup>	9.58 <sup>a</sup>	9.58 <sup>b</sup>	17.92 <sup>b</sup>	62.92 <sup>a</sup>	9.58 <sup>a</sup>
	SEM	2.256±	2.976±	1.359±	2.256±	2.256±	2.976±	1.359±	2.256±
Season	Winter	27.08 <sup>a</sup>	35.83 <sup>a</sup>	35.00 <sup>b</sup>	2.08 <sup>b</sup>	27.08 <sup>a</sup>	35.83 <sup>a</sup>	35.00 <sup>b</sup>	2.08 <sup>b</sup>
	Summer	5.83 <sup>b</sup>	21.67 <sup>b</sup>	64.58 <sup>a</sup>	7.92 <sup>a</sup>	5.83 <sup>b</sup>	21.67 <sup>b</sup>	64.58 <sup>a</sup>	7.92 <sup>a</sup>
	SEM	2.256±	2.976±	1.359±	2.256±	2.256±	2.976±	1.359±	2.256±
p. Value	Mean	16.46	28.75	49.79	5.00	16.46	28.75	49.79	5.00
	SEM	1.694	2.068	2.285	0.996	1.694	2.068	2.285	0.996
	C	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
	S	<.0001	0.0004	<.0001	0.0025	<.0001	0.0004	<.0001	0.0025
	S*C	0.2404	0.0117	0.7666	0.0095	0.2404	0.0117	0.7666	0.0095

GSO grading\*. SEM: standard error of means. Haugh unit grades AA:  $\geq 80$ ; A:  $\geq 71$ ; B:  $51 - 70$ ; C:  $\leq 50$ . Albumin pH percentages grade AA:  $7.6 - 9.3$ ; A:  $7.6 - 9.5$ ; B:  $7.6 - 9.5$ ; C: Undefined. <sup>a-c</sup>Values in the same column with same factor, with different superscript letters differ significantly ( $p \leq 0.05$ ).



in the winter. Figure 9 shows that the eggs purchased from groceries in the summer had significantly ( $p \leq 0.05$ ) the uppermost C HUGP, but the eggs purchased from supermarkets in the winter and summer and from grocery stores in the winter had statically similar C HUGP.

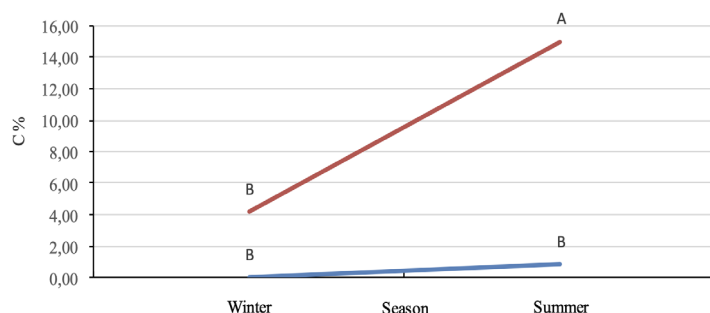


Figure 9 – The interaction effect of marketing channels and season on Haugh values.

### Albumin pH grades percentages (ApHGP)

Channels of marketing and season had a significant ( $p \leq 0.05$ ) effect on all of the studied traits, while their interaction had a significant effect ( $p \leq 0.05$ ) only on A and C of ApHGP. The eggs procured from supermarkets or in the winter had significantly the uppermost AA and A, and less B and C ApHGP than those acquired from grocery stores and in the summer, respectively (Table 4). Eggs bought from supermarkets in the winter and summer had statistically similar A ApHGP, however the eggs bought from grocery stores in the summer had significantly ( $p \leq 0.05$ ) the lowest A ApHGP. Eggs taken from grocery stores in the winter were statistically similar in their A ApHGP as those acquired from supermarkets in the summer, but significantly lower A ApHGP than those purchased from supermarkets in the winter (Figure 10). Table eggs obtained from

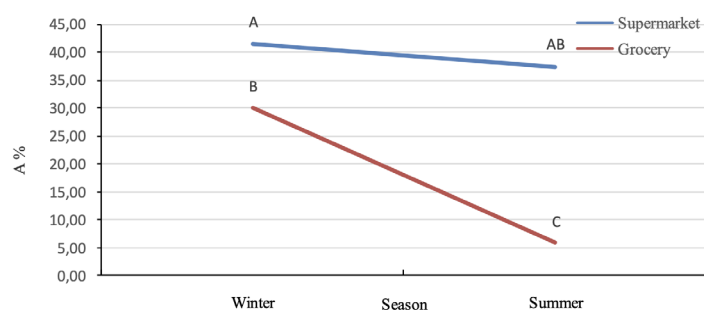


Figure 10 – The interaction effect of marketing channels and season on albumin pH values grade percentages.

groceries in the summer were significantly the highest in their C ApHGP, but the eggs bought from supermarkets in the winter and summer and from groceries in the winter had statically similar C ApHGP (Figure 11).

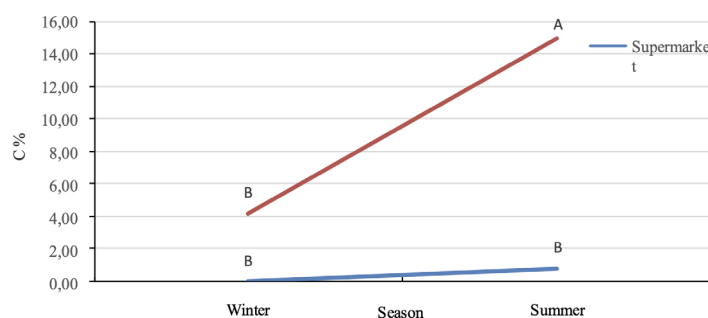


Figure 9 – The interaction effect of marketing channels and season on albumin pH values grade percentages.

## DISCUSSION

The outcomes of the study pinpoint significant ( $p \leq 0.05$ ) marketing channels, season and, season and marketing channel interaction effects on most studied egg quality traits and weight grades percentages. Eggs bought from supermarkets had significantly greater AA and A Haugh unit and albumin pH, moderate egg, AA air cell depth and weight class grades percentages than those procured from groceries. They also had less B, C Haugh unit and pH, A and B air cell depth, spot of dirt, very large, large and small egg weight grades percentages than those obtained from grocery stores. The results also indicated that eggs purchased from supermarkets had better quality than those bought from grocery stores, which might be due to better handling and storage conditions. Several researchers reported significant egg quality differences of eggs purchased from different marketing channels (Omar & Aref, 2000; Moula *et al.* 2013; Attia *et al.* 2014; Kara Ali *et al.* 2014; Ewonetu & Negassi 2016; Tolimir *et al.* 2017; Alshaikhi 2019; Alsobayel *et al.* 2020). These variations might be due to different strain, age of the bird, mass of egg, nutrition or storage period and conditions. On the other hand, eggs taken in the winter season had significantly higher grade AA and A Haugh unit and albumin pH, AA air cell depth, very large and large egg weight class, but have inferior B, C Haugh unit and pH, B air cell depth and small weight class grades percentages, than those acquired in the summer season. However, Moula *et al.* (2013) informed that eggs obtained in the summer had a significant higher extra-large, Large and medium but, small egg weight and AA Haugh unit grades percentages were lower than those of the eggs purchased in the winter season. These differences might be due to different strains and/or age of the birds, size of the egg, nutrition, heat stress or egg poor handling on farm and marketing channels.



## CONCLUSION

From the results of the study reported herein and under the experiment conditions, we conclude that channels of marketing and season have a significant impact on quality characteristics of Table eggs marketed in Riyadh city. Table eggs purchased from supermarkets or in the winter season showed better quality than those obtained from grocery stores and in the summer season. Grocery stores or small shops have to follow the handling and storage conditions requirements of Table eggs, especially in the summer season.

## ACKNOWLEDGEMENTS

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