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Utilization of Egg White in the Production of High-Protein Milk Beverages

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ABSTRACT

Milk and egg consumption are recommended during childhood due to their nutritional value, especially the high-quality proteins. Flavored milk beverages have a high preference among consumers, particularly among children. This study aimed to produce flavored dairy beverages enriched with pasteurized egg white at different levels to enhance protein percentage and nutrient value, and to study the chemical, microbial characteristics, and sensory attributes of these beverages. Three types of flavored milk beverages (vanilla, apple, and cocoa) were prepared with different egg white percentages (30%, 50%, and 70% w/w) those are T1, T2, and T3 respectively. The results of this study showed that increasing the egg white percentage significantly ($p \leq 0.05$) increased the protein% and decreased the fat%. Increasing the egg white percentage also increased the pH values and decreased the total bacterial count. Moreover, sensory evaluation of samples showed that the consumers' acceptance decreased after 50% added egg white. Control and T1 (30% egg white) vanilla beverage had the highest smell and taste, color, and appearance scores, while the T3 (70% egg white) apple beverage had the lowest smell and taste scores along with color and appearance scores. The body and consistency scores show no significant difference between treatments in vanilla and apple beverages, while the T3 sample of the cocoa beverage had the lowest body and consistency scores of all treatments.

1. INTRODUCTION

Sufficient nutrition during childhood is the basis of growth, development, and well-being. Worldwide, there is a remarkable increase in the consumption of unhealthy food instead of healthy food due to the fast lifestyle and the change in our eating habits. The low intake of milk, fruits, and vegetables, and the high intake of soft drinks and sweets are the leading causes of being overweight and obese **(Maged et al., 2019)**.

Dairy products provide children with energy, high-quality protein, and essential and nonessential fatty acids. It considers a source of multiple micronutrients, including calcium, phosphorus, magnesium, zinc, iodine, potassium, vitamins A, D, B12, and riboflavin (vitamin B2) **(Dror & Allen, 2014)**. Milk proteins are high-quality proteins that contain essential amino acids and bioactive peptides that may be present in milk or formed during the digestion of the proteins **(Molgaard et al., 2011)**. Egg protein has been known for being an excellent source of essential amino acids, and highly digestible. Many studies on egg protein have shown it

decreases malnutrition in developing countries and protect against kwashiorkor. **(Puglisi & Fernandez, 2022)**. Egg white proteins have the highest reference value of the parameter: protein digestibility-corrected amino acid score or (PDCAAS) and biological value or (BV**) (Stefanova et al., 2021).** Ready-to-drink (RTD) protein beverages with high nutritional value are trending in the recent food industry, these protein beverages are usually prepared with whey, milk, soy, and egg protein or a mixture of them. It was reported that juices are an excellent choice for producing flavorful dairy protein beverages with consumer acceptance. Juices can be used to add both flavor and sweetness **(Dairy Export Council, 2017).** Apple is a notoriously great source of high in-soluble dietary fiber, which is vital for healthy digestion and helps lower cholesterol and blood sugar. Apples can cure all kinds of stomach disorders in kids such as constipation, diarrhea, and dysentery **(Sheldon & Hall, 1939)**. Cocoa powder acts as a functional food because some of its components reported several health benefits. Cocoa contains a significant amount of fat, It also contains dietary polyphenols, and minerals such as potassium, phosphorus, copper, iron, zinc, and magnesium **(Montagna et al., 2019)**. The purpose of this study is to use bioactive ingredients to produce dairy beverages with different levels of pasteurized egg white with different flavors (vanilla, apple, cocoa) beside study some chemical and microbial changes and to report the evaluation of consumer acceptance of it as a healthier snack for children.

2. MATERIALS AND METHODS

2.1. Materials

For vanilla beverage preparation, UHT full cream cow's milk, pasteurized frozen egg white, sugar, vanilla extract, and carrageenan gum, plastic bottles were used in this experiment and they were obtained from the local market. The Same ingredients were used in the cocoa beverage in addition to pure cocoa powder. The apple beverage was prepared with the same ingredients as vanilla in addition to fresh mashed apples.

2.2. Methods

2.2.1. Preparation of samples

The control vanilla beverage was prepared by heating 250g of milk at 70°c in a water bath and adding 10% sugar (25g), 0.02% carrageenan gum (0.05g), and a pinch of vanilla extract. The mixture was stirred for a few minutes, then cooled to room temperature, and packed in plastic bottles. Treatments 1, 2, and 3 were prepared by heating respectively (175, 125, and 75g) of milk at 70°C in a water bath, adding sugar, carrageenan gum, and vanilla extract into the

different levels of pasteurized egg white (75, 125, 175g) respectively then added to heated milk. The mixture was stirred for a few minutes, then after optimum cooling at room temperature, and packing in plastic bottles, bottles were placed in the refrigerator. For cocoa drinks, the same ingredients as vanilla drinks were used in addition to 2% pure cocoa powder (5g). For apple drinks, the same ingredients as vanilla drinks were used in addition to 20% fresh mashed apple (50g).

2.2.2. Chemical analysis

According to AOAC 2012, Moisture content was determined by the oven drying method, total protein content was determined by the macro-Kjeldahl procedure, fat content was determined by the ANKOM technology method, and pH value was measured at 25°C using a digital pH meter (Jenway 3505 pH meter).

2.2.3. Microbiological analysis

Standard plate count in different types of beverages, coliforms bacterial count, and molds and yeasts count were determined according to AOAC 2004.

2.2.4. Sensory evaluation

The samples were examined according to the following organoleptic parameters: Smell and taste (50 marks), Body and consistency (20 marks), color and appearance (30 marks) **(Khatun & Islam, n.d. 2018)**.

The sensory evaluation of the samples was conducted by 20 panelists, the choice of panelists was based on availability.

2.2.5. Statistical analysis

Data were statically analyzed using IBM SPSS Statistics (version 20). The analysis of variance (ANOVA) one-way, and two-way tests were done. In case of significant differences, Duncan's Multiple Range Test (DMRT) was carried out to find out the significant difference among different treatment means.

3. RESULTS AND DISCUSSION

3.1. chemical composition

Results of the chemical composition of milk beverages enrichment with egg white are shown in Table (1). Data illustrated that the addition of pasteurized egg white significantly affected the chemical composition of samples. Increasing egg white percentage increased protein%, as well as decreased fat% however, the effect on total solids, varies according to beverage type, vanilla, and apple beverages treatments with (30% and 50% egg white) did not have a significant change in total solids, while cocoa beverage had a significant change in total solids of all treatments.

Table 1: Chemical composition of different flavored dairy egg white beverages

Flavor	Treatment	Protein %	Fat %	Moisture %	Total solids %
Vanilla	C	3.18 ± 0.04^{D}	2.92 ± 0.06^{A}	79.22 ± 0.06^{C}	20.78 ± 0.06^{A}
	T1	4.82 ± 0.06^{C}	1.93 ± 0.04^{B}	79.90 ± 0.03^{B}	20.1 ± 0.03^{B}
	T2	6.13 ± 0.07^{B}	1.58 ± 0.06^{C}	79.83 ± 0.03^{B}	20.17 ± 0.03^{B}
	T3	7.08 ± 0.06^{A}	0.80 ± 0.04^{D}	80.4 ± 0.06^{A}	19.60 ± 0.06^{C}
Apple	C	3.02 ± 0.11^{D}	2.88 ± 0.06^{A}	79.72 ± 0.05^{C}	20.27 ± 0.05^{A}
	T1	4.77 ± 0.06^{C}	1.88 ± 0.06^{B}	80.07 ± 0.09^{B}	19.93 ± 0.09^{B}
	T2	5.10 ± 0.09^{B}	1.53 ± 0.05^{C}	80.17 ± 0.04^{B}	19.83 ± 0.04^{B}
	T3	6.87 ± 0.08^{A}	0.93 ± 0.11^{D}	80.55 ± 0.1^{A}	19.45 ± 0.1^{C}
Cocoa	C	3.24 ± 0.06^{D}	3.02 ± 0.04^{A}	77.81 ± 0.06^{D}	22.19 ± 0.06^{A}
	T1	4.93 ± 0.06^{C}	2.08 ± 0.03^{B}	78.21 ± 0.04^{C}	21.79 ± 0.04^{B}
	T2	6.23 ± 0.05^{B}	1.62 ± 0.05^{C}	78.32 ± 0.04^{B}	21.68 ± 0.04^{C}
	T3	7.12 ± 0.07^{A}	0.96 ± 0.07^{D}	78.68 ± 0.06^{A}	21.32 ± 0.06^{D}

Values are expressed as mean ± SD (n=3). Numbers with different superscripts are significantly different ($P \leq 0.05$)
C: control beverages without egg white.
T1: beverages with 30% pasteurized egg white (w\w)
T2: beverages with 50% pasteurized egg white (w\w)
T3: beverages with 70% pasteurized egg white (w\w)

3.2. pH values

Results of the pH values of dairy egg white beverages are shown in Table (2). Data revealed that the addition of pasteurized egg white increased the pH values between treatments in each type of flavored beverage in fresh samples and during storage time due to the naturally alkaline properties of egg white **(Guyot et al., 2016)**, the pH value in the Control apple beverage after a week from storage period was the least of the flavored beverages as apple is an acidic fruit, while T3 fresh cocoa beverage had the highest pH value. It was concluded that at lower pH levels of 4.0–5.0, Lactic acid bacteria can grow and increase the acidity level thus decreasing the product quality and its shelf life therefore, it was concluded that egg white can reduce milk spoilage by increasing pH levels **(Lotfian et al., 2019)**

Table 2: pH values of different flavored dairy egg white beverages

Flavors / Treatments	Vanilla		Apple		Cocoa	
	Fresh	After a week	Fresh	After a week	Fresh	After week
C	7.21	7.18	6.72	6.7	7.65	7.77
T1	7.89	7.94	7.35	7.41	8.26	8.53
T2	8.35	8.32	7.87	7.84	8.61	8.73
T3	8.68	8.71	8.08	8.11	8.95	9.58

Values are expressed as mean
C: control beverages without egg white.
T1: beverages with 30% pasteurized egg white (w\w)
T2: beverages with 50% pasteurized egg white (w\w)
T3: beverages with 70% pasteurized egg white (w\w)

3.3. Microbial counts

Results of total bacterial count in different flavored dairy egg white beverages are shown in Table (3). Data showed that the addition of pasteurized egg white decreased the total bacterial count and prevented the overgrowth of bacteria which was observed by increasing the egg white percentage. It can be illustrated due to egg white proteins' anti-bacterial activity **(Jalili-Firoozinezhad et al., 2020).** The cocoa beverage has a higher total plate count either fresh or during storage samples. Coliforms or yeast and molds were not detected in all samples.

Table 3: Microbiological values (Log_{10} CFU/ml) during storage of different flavored dairy egg white beverages

Flavors / Treatments	Vanilla		Apple		Cocoa	
	Fresh	After a week	Fresh	After a week	Fresh	After a week
C	3.82	3.83	3.86	3.93	3.93	3.94
T1	3.77	3.80	3.81	3.86	3.86	3.88
T2	3.72	3.79	3.79	3.82	3.83	3.86
T3	3.72	3.75	3.76	3.80	3.80	3.81

C: control beverages without egg white.
T1: beverages with 30% pasteurized egg white (w\w)
T2: beverages with 50% pasteurized egg white (w\w)
T3: beverages with 70% pasteurized egg white (w\w)

3.4. Sensory evaluation

Sensory evaluation results of dairy egg white beverages are shown in Table (4). Data illustrated that the control C beverage and T1 (30% egg white) of vanilla beverages had the highest score for smell and taste, on the other side T3 (70% egg white) of apple beverages had the lowest score. The addition of pasteurized egg white decreased the score of smell and taste significant for T3 (70% egg white) in the vanilla drink beside T2 (50% egg white) and T3 (70% egg white) in the cocoa drink. Results also illustrated that control C and T1 (30% egg white) of vanilla beverages had the highest score for color and appearance further T3 (70% egg white) of cocoa beverages had the lowest score, and the addition of pasteurized egg white decreased the color and appearance score significantly for T2 (50% egg white) and T3 (70% egg white) of vanilla beverages in addition to T3 (70% egg white) of cocoa beverages. The body and consistency score of vanilla and apple beverages have no significant difference between treatments, as well as cocoa beverages treatments except in T3 (70% egg white) which had the lowest body and consistency score because it showed changes in texture that are best described as rubbery texture. Other studies have demonstrated the difference between consumer preferences for all protein beverages was according to flavor, price, and protein content ***(Liu et al., 2021)***

Table 4: The sensory evaluation of different flavored dairy egg white beverages

Flavor	Treatment	*Storage period*	Smell & taste (50)	Color & Appearance(30)	Body & consistency(20)
Vanilla	C	Fresh	48.40±1.14	28.40±0.89	18.40±1.95
		After a week	49.20±0.84	28.40±0.55	19.20±0.45
		Total	48.80^{A}	28.40^{A}	18.80^{A}
	T1	Fresh	48.80±0.84	28.40±0.89	18.40±1.95
		After a week	49.40±0.89	28.40±0.55	19.20±0.45
		Total	49.10^{A}	28.40^{A}	18.80^{A}
	T2	Fresh	47.80±1.92	27.20±0.84	18.40±1.34
		After a week	48.20±1.10	26.80±0.84	19.20±0.45
		Total	48.00^{AB}	27.00^{B}	18.80^{A}
	T3	Fresh	46.80±1.48	26.80±1.10	18.35±1.60
		After a week	47.20±1.48	26.20±1.10	19.05±0.69
		Total	47.00^{B}	26.50^{B}	18.40^{A}
Apple	C	Fresh	40.20±12.15	24.60±4.7	14.60±2.88
		After a week	43.60±3.05	27.20±4.15	15.40±2.88
		Total	41.90^{A}	25.90^{A}	15.00^{A}
	T1	Fresh	41.00±10.25	27.60±2.30	17.20±2.17
		After a week	44.60±1.52	25.60±4.56	15.40±2.88
		Total	42.80^{A}	26.60^{A}	16.30^{A}
	T2	Fresh	43.60±4.98	25.80±3.77	17.20±4.15
		After a week	44.20±2.95	24.60±3.85	13.80±2.39
		Total	43.90^{A}	25.20^{A}	15.50^{A}
	T3	Fresh	39.80±11.52	26.60±2.30	16.20±3.90
		After a week	37.80±10.26	24.0±4.24	14.20±2.78
		Total	38.80^{A}	25.30^{A}	15.20^{A}
Cocoa	C	Fresh	45±3.33	24.8±5.1	16.2±1.99
		After a week	46.4±5.17	27.1±3.45	17.6±3.47
		Total	45.70^{A}	25.95^{AB}	16.9^{A}
	T1	Fresh	44±5.56	27±4.08	16.4±3.13
		After a week	44.4±6.42	27.2±3.55	17.9±2.13
		Total	44.20^{A}	27.1^{A}	17.15^{A}
	T2	Fresh	40.6±8.95	24.3±5.81	16.5±3.89
		After a week	35.5±8.95	25.2±4.37	16.8±1.99
		Total	38.05^{B}	24.75^{AB}	16.65^{A}
	T3	Fresh	33.2±8.57	20.8±5.25	12.6±4.84
		After a week	39.3±4.83	25.5±3.63	16.7±1.64
		Total	36.25^{B}	23.15^{B}	14.65^{B}

Values are expressed as mean ± SD (n=20). Numbers with different superscripts are significantly different (P ≤ 0.05)
C: control beverages without egg white.
T1: beverages with 30% pasteurized egg white (w\w)
T2: beverages with 50% pasteurized egg white (w\w)
T3: beverages with 70% pasteurized egg white (w\w)

4. CONCLUSIONS

Because childhood is a critical development stage, dairy egg white beverages are a possible option for facing malnutrition as a functional food. Utilizing pasteurized egg white to enrich flavored dairy beverages has enhanced the protein percentage as well as improved the nutritional quality and the treatments' shelf life, while sensory quality depends on the pasteurized egg white percentage. It was observed that beverages with (70% pasteurized egg white) did not have the same consumer acceptance as the other treatments. Vanilla-flavored egg white beverages had the highest score among the different types. Using other commercial egg white products, such as dried egg white powder, in dairy products should be more thoroughly investigated.

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استخدام بياض البيض لإنتاج مشروبات لبنية عالية البروتين

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مجلة العلوم الزراعية والبيئية المستدامة

الكلمات المفتاحية: كاكاو، بياض بيض، بروتين، مشروبات لبنية، خواص حسية

الملخص

يعتبر البيض واللبن من اهم الاغذية الموصي باستهلاكها في مرحلة الطفولة بسبب قيمتها الغذائية خاصة محتواها من البروتين عالي القيمة الحيوية علاوة على ذلك تعدّ المشروبات اللبنية ذات النكهات من المنتجات المفضلة لدى المستهلكين خاصة الاطفال. هدف هذه الدراسة انتاج مشروبات لبنية بنكهات مختلفة معززة ببياض البيض المبستر بتركيزات مختلفة لرفع نسبة البروتين ودراسة التغيرات الكيميائية والميكروبية وتقييم الخصائص الحسية لهذه المشروبات. تم تحضير ثلاثة انواع من المشروبات اللبنية بإضافة نسب مختلفة من بياض البيض المبستر (30،50،70%)، اظهرت النتائج انه بزيادة نسبة بياض البيض تزداد نسبة البروتين معنويا في المشروبات بينما تقل نسبة الدهن. كذلك فان زيادة نسبة بياض البيض ادت الى زيادة الاس الهيدروجيني للعينات والذي بدوره اظهر انخفاض في العدّ الكليّ للبكتريا في العينات. علاوة على ذلك اظهرت نتائج التقييم الحسيّ تقبل المستهلك للمشروبات حتى نسبة اضافة 50% من بياض البيض المبستر ثم انخفض التقييم. حصلت المعاملة القياسية والمعاملة الاولى من مشروب الفانيليا على اعلى درجات تقييم للطعم والرائحة، اللون، كذلك المظهر بينما حصلت المعاملة الثالثة من مشروب التفاح على اقل التقييمات. لم تظهر نتائج القوام اختلافا معنويا بين المعاملات في كل من مشروب التفاح والفانيليا بينما حصلت المعاملة الثالثة من مشروب الكاكاو على اقل تقييم بالنسبة للمعاملات الاخرى من مشروب الكاكاو.