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Study of Fluctuations in Vitamin D Levels in Eggs Depending on the Season

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Abstract: Determining the vitamin D levels in common foods is crucial for both preventing and treating conditions associated with vitamin deficiencies and maintaining overall well-being. This study aimed to investigate how seasonal variations impact the vitamin D content in eggs. In this experiment, egg yolks from local domestic chickens and a German breed were utilized as biomaterial. These chickens were housed under standard conditions in the vivarium of the Central Scientific Research Laboratory. The findings revealed that the vitamin D content in eggs from domestic hens was 11.89% higher in winter, 50.0% higher in spring, and 44.0% higher in summer compared to eggs from the German breed.

Key points: cholecalciferol, ergocalciferol, colorimetry, calcidiol.

Introduction. Traditionally, vitamin D has been recognized for its crucial role in supporting the health of the musculoskeletal system. However, emerging evidence indicates that inadequate levels of the active form of vitamin D, 1,25-dihydroxycholecalciferol, are associated with various non-skeletal conditions such as specific types of cancer, hypertension, age-related cognitive decline, immune system irregularities, and reproductive issues. To prevent these conditions, it is essential to maintain elevated levels of 1,25- dihydroxycholecalciferol in the bloodstream beyond the usual requirement for bone health, calcium absorption, and calcium balance [1-5].

Therefore, it is imperative to assess the vitamin D content in common foods to prevent and manage disorders linked to vitamin deficiencies and to support overall physiological well-being.

Both cholecalciferol (vitamin D3) and ergocalciferol (vitamin D2) play key roles in facilitating the absorption of calcium and phosphorus in the small intestine, primarily in the duodenum. The significance of vitamin D for the human body is well acknowledged as it influences skeletal system development and various non-skeletal effects of cholecalciferol. As a steroid hormone, vitamin D is essential for hormonal balance and contributes to numerous physiological processes, thereby influencing overall human health [6-10].

Ergocalciferol (vitamin D_2) and cholecalciferol (vitamin D_3) are the two primary forms of vitamin D that are vital for maintaining optimal health and supporting various bodily functions.

The process of vitamin D activation and its effects on the human body are quite fascinating. Vitamin D exists as a provitamin in both forms, and its activation involves hydroxylation in the liver, leading to the production of 25-hydroxy-cholecalciferol (calcidiol) as an intermediate. This compound is then further converted to the active form of vitamin D, known as 1,25-dihydroxy-cholecalciferol (calcitriol or D-hormone), through the action of 1-hydroxylase.

Calcitriol interacts with the vitamin D receptor (VDR), a nuclear steroid receptor and intracellular transcription factor found in various organs, to exert its effects. The regulation of VDR expression is a crucial mechanism through which target cells respond to calcitriol, and variations in VDR polymorphisms can impact normal physiological functions. Vitamin D receptors are distributed in tissues like the uterus, ovaries, placenta, and pituitary gland.

Functionally, vitamin D has various impacts on the body, including inhibiting the renin-angiotensin system, reducing vascular smooth muscle cell proliferation, decreasing blood insulin levels, promoting endothelium-dependent vasodilation, and inhibiting coagulation. These effects collectively contribute to the prevention of arterial hypertension. Moreover, the active form of vitamin D also plays a role in regulating the expression and activity of genes involved in processes like trophoblast invasion, proper implantation, and angiogenesis.

In the contemporary global and local agricultural landscape, poultry farming, specifically chicken farming, is recognized as a cutting-edge and evolving industry. The sector's prominence stems from the exceptional quality of poultry meat and the widespread availability of eggs, which serve as a valuable and affordable protein source for diverse population groups. In present-day dietary considerations, in addition to fulfilling the body's energy and structural requirements, there is a growing emphasis on integrating preventive and therapeutic components.

By enriching chicken diets with eco-friendly and potent supplements, it is possible to create food items with specific characteristics, such as fortified eggs. This approach enables the development of poultry products with enhanced nutritional profiles and potentially beneficial health properties, aligning with the evolving demands of the modern consumer seeking both sustenance and well-being [11-15].

Aim. Explore the impact of seasonal changes on the levels of vitamin D in chicken eggs.

Material and methods. In our research experiment, our main objective was to measure the levels of vitamin D_3 in chicken eggs. Firstly, we performed qualitative examinations to confirm the existence of vitamin D in chicken eggs. We utilized an alcoholic egg extract solution and a bromine solution in chloroform (1:60) in a dry test tube. The solution obtained displayed a greenish-blue tint, signifying the presence of vitamin D. Furthermore, applying a chloroform solution of antimony pentachloride on the chromatogram of an ethanol egg extract produced a brownish-blue shade, indicating the existence of group D vitamins.

Efforts to utilize electrophoretic methods and column chromatography for separation were hindered by the complex nature of the biomaterial, which contains around 50 different trace elements and compounds. It was observed that vitamin D3 forms a sturdy complex conglomerate with phospholipids, proteins, amino acids, and other nitrogenous bases present in the egg. To disintegrate this intricate structure, acetyl chloride was employed as an acylating agent to bind high-molecular protein components and compounds containing nucleophiles such as amino acids and phenols.

In the experiment, vitamin D_3 in the biomaterial was linked with antimony (III) chloride to generate a colored product. This aided in determining the optical density as a means to quantify the amount of vitamin D_3 present. The use of these techniques allowed for a better understanding of the complex composition of the biomaterial and the quantification of vitamin D_3 within the egg samples.

A calibration curve was established by plotting the optical density (D) values of the solutions at 260 nm. For our experiment, we utilized egg yolks from local domestic chickens and chickens of the German breed, both maintained at the vivarium of the Central Scientific Research Laboratory under standardized conditions.

Results and discussion.

The obtained research data are presented in Table 1.

Table 1. The results of determining the content of vitamin D_3 in chicken eggs in different seasons of the year (in mcg/100g)

experience №	Winter		Spring		Summer	
	German breed	Local breed	German breed	Local breed	German breed	Local breed
n 1	4,0	4,1	6	9,2	6,2	9,5
n 2	3,3	3,9	5,0	8,6	7,0	9,6
n 3	3,1	4,2	7	8,0	7,2	8,9
n 4	4,1	4,0	6,9	9,6	6,0	9,
n 5	4,0	4,5	5,1	9,7	6,6	9,6
∑ n	18,5	20,7	30	45,1	33,0	47,8
$\sum_n/n$	3,7	4,14	6,0	9,0	6,6	9,5
Δ±s	0,7	0,8	0,7	1,6	1,3	1,7

Table 1 shows that the quantitative indicators of vitamin D_3 in the egg yolk of German breed chickens in all seasons are significantly lower than in local chickens.

In the German breed, the vitamin D values were 3.7±0.7 mcg per 100g of product in winter, 6±0.7 mcg per 100g of product in spring, and 6.6±1.3 mcg per 100g of product in summer. On the other hand, in the eggs of the local breed, these values were 4.14±0.7 µg, 9.0±1.6 µg, and 9.5±1.7 µg, respectively. The analysis results indicate that the quantitative levels of vitamin D in chicken egg yolks vary with the seasons of the year.

During the winter period, the vitamin D content in eggs from domestic chickens was 11.89% higher compared to the German breed. In the spring, this difference increased to 50.0%, and in the summer, it was 44.0% higher than in eggs from German chickens. The study demonstrates that the vitamin D content in eggs from both breeds of hens fluctuates significantly depending on the season.

Conclusions. The quantitative measurement of vitamin D content in chicken egg yolks varies depending on the season. In winter, German chickens' eggs contain 3.7 ± 0.7 µg per 100 g of product, while in spring it increases to 6 ± 0.7 µg per 100 g and in summer it reaches 6.6 ± 1.3 µg per 100 g. On the other hand, in the eggs of the local breed, the values were 4.14 ± 0.7 µg, 9.0 ± 1.6 µg, and 9.5 ± 1.7 µg, respectively.

The vitamin D content in eggs from domestic hens is 11.89% higher in winter, 50.0% higher in spring, and 44.0% higher in summer compared to eggs from German breeds. This demonstrates significant seasonal variability in the vitamin D levels found in eggs from different chicken breeds.

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