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EFFECT OF USING DIFFERENT LEVELS OF SUGAR BEET PULP SUPPLEMENTED WITH SWEET RED PEPPER IN THE DIETS ON THE PERFORMANCE OF GOLDEN MONTAZAH LAYING HENS

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ABSTRACT: The current research aimed to study the effect of inclusion of different levels of sugar beet pulp (SBP) in the diets supplemented with sweet red pepper (SRP) or without supplementation on the performance of Golden Montazah (GM) laying hens. The experiment started at 197 days of age preceded by an adaptation period of 28 days and ended at 280 days. A total number of 360 hens at 29 weeks were randomly divided equally into 10 treatments (0.0, 5.0, 10.0, 15.0, and 20.0%SBP, each one without or with 0.1%paprika) groups (36 hens /3 replicates /12 hens each).

All dietary treatments (SBP%×SRP%) improved egg weight (EW) over the period from 29–40 weeks. hens fed 20%SBP with 0.1%SRP had significantly higher EW and feed intake values during this period, but, hens fed control diet had significantly lower values. However, this effect was not statistically significant on egg number, egg production, feed conversion ratio, crude protein conversion and caloric efficiency ratio over the same period.

Dietary treatments insignificantly affected albumen%, yolk%, yolk index%, shell%, shell thickness and HU, but, had significantly affected, shape index and yolk color (YC) at the mean of three periods (32, 36 and 40 weeks). Hens fed 0.0%SBP with 0.1%SRP and 20% SBP with 0.1%SRP had higher value of egg YC at the mean of three periods, but, hens fed 5% SBP with 0.0%SRP and 20%SBP with 0.0%SRP had lower value.

Conclusion: The results showed that the most economically effective level of SBP was obtained from the control diet, followed by those fed diet containing 5% SBP. Depending on market conditions and financial circumstances, this can reach 15% with or without the addition of 0.1% SRP to GM laying hens' diets without any negative impact on performance.

Key words: sugar beet pulp, paprika (sweet red pepper), performance, egg quality, laying hens.

INTRODUCTION

Yellow corn makes up, 60-70% of the feed used for various poultry species. Humans consume most of Egypt's local corn production, creating a gap between locally available feedstock and the growing demand for poultry feed. The depreciation of the Egyptian currency in recent years has also negatively impacted the prices of all imported raw materials, particularly corn and soybeans. So, extensive efforts were made to find local feed alternatives that meet nutritional needs. The waste of local agricultural and industrial products has been an incentive to develop partial substitutes that reduce production costs and imports.

Globally, sugar beet (*Beta vulgaris L.*) is one of the most important agricultural and industrial crops for sugar production, particularly in temperate regions (about a third of the total sugar produced). According to the Food and Agriculture Organization, FAO (2025), in 2023 global sugar beet production reached 281,194,600 tons; African production reached 14,370,000 tons and Egypt's production reached 12,794,000 million tons, representing 4.55% of global production and 89.03% of the total production of the African continent. Assuming that every 1000kg of processed sugar beets produces 55 kg/ton (5.5%) of dried SBP, according to Mirzaei-Aghsaghali and Maheri-Sis (2008), approximately 703,670 tons of Egyptian dried SPB production are available for livestock feed in 2023. Sugar beet pulp (SBP) is a by-product of extracting sugar from sugar beets, and is dried immediately after processing. When yellow corn is partially or completely replaced by SPB (which contains no or low pigments (carotenoids)) in the diet of laying hens, the egg yolk color (YC) becomes pale, which is undesirable for consumers and food manufacturers that rely on eggs in their products. To address this deficiency, natural pigments, such as red peppers (RP), must be added instead of artificial ones.

Our previous work (Emam and Abdel Wahed, 2020) noted that including SBP in the diets of levels ranging from 5 to 20% resulted in a non-significant partial reduction in YC compared with those consumed 0.0% SBP. So, in future studies, we need to add appropriate pigment sources in the diet of laying hens especially when fed SBP for YC safety. This is consistent with another previous study by Galobart et al. (2004) who reported that different sources of carotenoids should be added to the diet of laying hens when using low-carotenoid ingredients, to get the desired egg YC. Also, in this respect, Santos-Bocanegra et al. (2004) and Shahsavari (2014) reported that in countries where based on grains other than yellow corn in laying hens diet, it is essential to add both yellow and red dyes since the specific egg YC is achieved by combining different levels of red and yellow xanthophyll. When replacing yellow corn (total or partial) with sorghum (Freitas et al. (2014) and Kufel et al. (2019) or wheat (Fassani et al., 2019) in the diet of laying hens, natural pigments should be added especially when using non-traditional feed ingredients in the diets.

Currently, consumer concerns about the use of artificial additives in food and feed have increased their interest in environmentally friendly, natural alternative products. In this respect Spasevski et al. (2016) noted that due to accumulated general concern about reliance on synthetic dyes, alternative natural dyes sources have been proposed. In addition, the search for natural dyes has increased as a result of the recent ban by the FAO of the United Nations, World Health Organization (WHO) on most artificial dyes in laying hens' feed (Valentim et al., 2019).

In light of this situation, and with the current growing consumer demand for healthy and natural products, several plant raw materials (plant pigments) can be used as a natural source of carotenoids in the diet of laying hens, such as yellow corn, an amaranth (marigold), dehydrated alfalfa, corn gluten meal, carrots, mulberry pumpkin, paprika (sweet pepper), tomatoes etc. (Lokaewmanee et al., 2010), RP extract, algae, tomato powder and marigold flower extract (Matache et al., 2024), paprika, calendula, flower, annatto, and turmeric (Fassani et al., 2019 and Valentim et al., 2019). Carotenoids are synthesized *de novo* by plants; they occur naturally in food products and do not need any metabolic modification (Marounek and Pebriansyah, 2018). Given their potential to prevent nutrition-related diseases and promote consumers' physical and mental health, eggs are classified as functional foods, especially when the feed of laying hens is enriched with natural extracts.

Eggs are a major natural source of carotenoids (preformed vitamin A) or the precursor to retinol in the human food, particularly xanthophylls, zeaxanthin, and lutein, for its role in decreasing or preventing cataracts and age-linked macular degeneration (Abdel-Aal et al., 2013 and Demmig-Adams et al., 2020) or defend it from UV damage caused by blue light (Vishwanathan and Johnson, 2013). Also, Brossaud et al. (2017) reported that retinol and its metabolites, like retinoic acid, play a role in protein digestion, immunity, eye function, tissue repair, and brain function Also, cancer prevention is one of the most important health benefits of carotenoids (Jeurnink et al., 2015; Leoncini et al., 2015 and Tuli et al., 2015), carotenoids are also associated with bone health (Tanumihardjo and Binkley, 2013). Carotenoids are also responsible for egg YC, a nutritional response that depends on their content, type, and concentration (Santos-Bocanegra et al., 2004; Rezaei et al., 2019 and Matache et al., 2024). The egg YC is based on the presence of carotenoids in the diet of laying hens, which transfer 20 to 60% of the color of the feed to the yolk, as they cannot synthesize pigments through their own biochemical processes (Li et al., 2012).

The digestive capacity of birds, absorption efficiency, and metabolic processes, as well as the sedimentation rate and amount of pigments present in their feed, are the basis on which the distribution of pigments to specific tissues depends (Chaves et al., 2022). The function of egg yolk is to provide the bird embryo with the nutrients and active substances necessary for its development. Moreover, carotenoids play an essential role in the health of the growing embryo, particularly their protective antioxidant effect, which are important for reducing the rate of lipid oxidation in egg yolk and the degradation of egg albumin. These reactions result in the loss of water and carbon dioxide, which increases the pH of the egg (Oliveira et al., 2017). Carotenoid are antibacterial, anti-inflammatory, immunomodulator, and antioxidant, therefore, they may increasing egg production (EP), egg weight (EW), and enhance feed conversion ratio, FCR (Milani et al., 2017; Arain et al., 2018 and Nabi et al., 2020). Carotenoids are widely used in laying hens' diets due to their numerous benefits, ensuring their suitability for use as functional foods and improving internal egg quality. Carotenoids enhance the orange color of egg yolks, an important factor in shoppers' food choices (Marounek and Pebriansyah, 2018).

There is a growing global search for healthy and natural alternatives to artificial dyes and medical usages in poultry diets. Numerous natural sources with high potential for poultry feed additives have been recognized and studied. Therefore, the widespread availability of feed additive alternatives is crucial to protecting the poultry industry, particularly in developing countries. Also, Matache et al. (2024) noted that natural dyes can also be used in laying hens diets as stimulants for growth or EP. Grashorn (2016) reported that, this may be a means of attaining satisfactory egg yolk pigmentation, besides preventing nutritional insufficiencies such as retinol lack and subordinate nutritional insufficiencies, in addition to diseases related to oxidative processes.

Sweet Red pepper (SRP) or Paprika (*Capsicum annuum L.*) is one of the most commonly used natural foodstuffs in international cuisine and traditional medicine, and has been evaluated in terms of its natural antioxidant potential and carotenoids nature (Matache et al., 2024). It has medicinal, coloring, flavoring, and preservative properties, in addition to its use in the food industry. It contains high levels of potassium, folic acid, and vitamins A, C, and E (Ozer, et al., 2006; Lokaewmanee et al., 2013 and Matache et al., 2024). The carotenoid pigments ranging from 0.3 to 3.2% on dry weight (Daood et al., 1996) that give RP their color are capsanthin, capsorubin, and capsanthin 5,6-epoxid (Palevitch and Craker, 1995 and Marounek and Pebriansyah, 2018). Due to these pigments, dried pepper powder is added to hens' diet to improve the yellow color of egg yolks (Al-Kassie et al., 2011 and Sharma, et al., 2012). Regarding consumer purchasing behavior, egg YC is a crucial factor that is very essential in the market (Li et al., 2012). In other words, other researchers suggest that peppers may have a positive or negative effect on the productivity of laying hens (Yang, 2009 and Sozcu, 2019), and the hen's feed intake (Cervantes-Paz et al., 2014). Improved YC of eggs for laying hens (ISA Brown) was observed by the use of sweet pepper in diets containing 50% wheat (Galobart et al., 2004).

Therefore, the aim of the current research was to study the impact of containing various levels of SBP added with 0.1% paprika (SRP) in Golden Montazah (GM) laying hens diet on performance.

MATERIALS AND METHODS

The current research aimed to study the effect of inclusion of different levels of SBP in the diets supplemented with 0.1% SRP (paprika) or without supplementation on the performance of GM laying hens. The experiment started at the age of 197 days preceded by an adaptation period of 28 days (the hens were fed the control diet during the adaptation period) and ended at 280 days of age.

Air-dried SBP (a by-product of sugar industry) samples were randomly collected from Fayoum Sugar Factory Company (sugar factory in Atsa, Fayoum Governorate) in the mash form. The GM laying hens were raised under the natural environmental conditions of Fayoum farms, Egypt. Extra artificial light source was used, 100 watt lamps with 3 m distance from each other and in 2.30 m height from the ground were considered for lighting giving a total of 16 hours as natural plus artificial light per day (16 light:8 darkness, lighting program), throughout the experimental period (12 weeks). All hens were fed with experimental diets (mash feed and water were provided *ad libitum*) from 29 to 40 weeks old.

The total number of the experimental included 360 hens at 29 weeks age was randomly divided equally into 10 treatments groups (36 hens each); each treatment was equally subdivided into three replicates of 12 hens each.

The nutritional treatments used in this research were as follows:

1- Hens were fed control diet (D1).

2- Hens were fed D1 supplemented with 0.1% Sweet Red Pepper (SRP), commonly known as paprika.

3- 5% from D1 was substituted by sugar beet pulp (SBP).

4- 5% from D1 was substituted by SBP supplemented with 0.1% SRP.

5- 10% from D1 was substituted by SBP.

6- 10% from D1 was substituted by SBP supplemented with 0.1% SRP.

7- 15% from D1 was substituted by SBP.

8- 15% from D1 was substituted by SBP supplemented with 0.1% SRP.

9- 20% from D1 was substituted by SBP.

10-20% from D1 was substituted by SBP supplemented with 0.1% SRP.

The basal experimental diets (control) were formulated to satisfy nutrient requirements (iso-nitrogenous and iso-caloric) of GM laying hens (16%CP and 2700 Kcal ME/Kg diet) based on the Egyptian Agriculture Ministry Decree No 1498 (1996) issued by Ministry of Agriculture. Amino acid levels were modified by adding lysine-HCl and DL-methionine. Tables 1a and 1b shows the composition and calculated chemical analyses of the experimental diets. The nutrients are calculated according to N.R.C. (1994).

Experimental diets were supplemented with vitamins (Vit.) and trace minerals (Min.) mixture premix manufactured by Faster Vet Company, Egypt. The experimental diets were weighed daily and their residues left in troughs were weighed at the end of each 7 days.

The following parameters were estimated and/or calculated: Egg number (EN), where EN/hen/period= EN produced/number of live hens; average EW where, average EW/treatment=(the sum of individual weight of the collected eggs/treatment)/EN; EP% as hen day EP, daily feed intake (FI); FCR where, FCR=FI/((EN*EW) or egg mass); crude protein conversion (CPC) where, CPC=FI*CP%/(EN*EW)) and caloric efficiency ratio (CCR) where, CCR=FI*ME. K Cal/(EN*EW)).

A total of 150 eggs (15 eggs from each group) were randomly collected every 4 weeks throughout the experimental period (at the end of weeks 32, 36, and 40 weeks of age; on eggs of the last 3 days of the month) and it is used to determine egg quality. Each egg was weighed individually and then cracked onto a flat glass plate to limit egg quality characteristics. Yolk diameter and height were measured, and albumen height was evaluated to the nearest 0.1 mm midway between the edge of the thick inner albumen and the yolk using an electronic albumen height gauge. The yolk was separated from the albumin and weighed. To evaluate egg's YC, the color fan on a scale of 1 to 15 from the "Roche 1961 Improved Egg YC Fan" was used.

The same person performed all of the egg YC determinations. The weight of the albumen was calculated by subtracting the weight of the shell and yolk from the EW. At room temperature, the eggshells were left to dry for three days and then weighed; egg shell thickness (including shell membranes) was measured with a micrometer at three locations on the egg (air cell, equator, and pointed end).

Haugh units (HU) score are applied from a special chart using EW and albumen height which was measured by with a micrometer according to Haugh (1937), HU=100log (albumen height (mm)+7.57 – 1.7 $W^{0.37}$) where, W=observed weight of an egg in grams. The egg shape index% (Carter, 1968) and yolk index% (YI%) where, YI%= YI%=(yolk height/yolk diameter)X100) according to Well (1968).

The economic efficiency of EP was calculated through input-output analysis using data from feed expenditures, egg sales income, and finally absolute revenue realization. Other costs (husbandry expenses, medical treatments, wages etc.), have not been considered, knowing they were identical for both groups during the entire experimental period. These values were calculated as net revenue per unit of total costs (LE/hen) based on local market prices for experimental feed ingredients. The price of a kilogram of SBP is 6 Egyptian pounds, and the price of a kilogram of SRP supplements is 40 Egyptian pounds.

Statistical analysis of results will be performed via the General Linear Models procedure of the SPSS software (SPSS, 2007), according to the follow general model:

$Y_{ijk}= \mu+L_i+R_j+LR_{ij} +e_{ijk}$ Where: Y_{ijk}: observed value. μ: overall mean.

L_i: Level of SBP effect (i: 0.0, 5, 10, 15%and 20%SBP).

R_j: Level of sweet red pepper effect (j: 0.0 and 0.1%)

$LR_{ij:}$ Interaction effect of level of SBP by SRP.

e_{ijk}: Experimental random error.

According to Duncan (1955), treatment means indicating significant (P≤0.01 and P≤0.05) differences were tested using Duncan's multiple range test**.**

RESULTS AND DISCUSSION

Laying hens productive performance: Data in Table (2) shows the effect of using various levels of SBP with or without adding SRP in the diets of GM laying hens on EW and EN. As for the level of SBP%, there was a significant difference (P≤0.001) for all study periods (29-32, 33-36, 37-40 and 29-40 weeks of age) for EW. Golden Montazah laying hens fed 5 and 20% SBP in the diet recorded significantly higher EW value during the total period, noting that all groups fed SBP significantly outperformed the control group, except those fed 15%SBP during the period of 33-36 weeks). However, GM laying hens fed a control diet (0.0%SBP) showed significantly lower EW value during the other periods.

Inclusion of 0.1%SRP in the diet of GM laying hens significantly affected (P≤0.001) EW during the periods from 29-32, 33-36, and 29-40 weeks of age, hens fed 0.1%SRP in the diet had significantly higher EW values during these periods (Table 2).

The interaction between SBP×SRP% in diet (treatment effect) had a significant effect (P≤0.001) on EW during all study periods (Table 2). All dietary treatments improved EW during the periods 29–32, 33–36, 37–40 and 29–40 weeks of age, compared to control group. Golden Montazah hens fed 20%SBP with 0.1% SRP in the diet had significantly higher EW values during the periods of 29-32, 33-36 and 29-40 weeks and those fed 5%SBP with 0.0%SRP in the diet had significantly higher EW value during the period of 37-40 weeks, but, GM laying hens fed a control diet had significantly lower EW value during all studied periods (Table 2).

The main effects of level SBP%, SRP% and their interaction had insignificantly (P>0.05) affected EN and EP% during all studied periods, except, for SBP level at (P≤0.001) and the interaction at (P≤0.01) during the period from 37 to 40 weeks, which was significantly affected (Tables 2 and 3). Golden Montazah laying hens fed 15%SBP recorded significantly higher EN and EP% values during the period from 37 to 40 weeks (while those fed 10%SBP in the diet had significantly lower EN and EP% values) and hens fed 15%SBP with 0.0% SRP had significantly higher EN and EP% values during the same period, but, GM laying hens fed 10%SBP with 0.1%SRP in the diet had significantly lower EN and EP% values during the same period.

The main effects of SBP% had significantly (P≤0.001) affected FI during all periods studied, GM laying hens fed 20%SBP had significantly higher FI values during the periods 29–32, 33–36, 37–40 and 29–40 weeks and GM laying hens fed 0.0%SBP in the diet had significantly lower FI values during the periods 29–32, 33–36 and 29–40 weeks, while, GM laying hens fed 10%SBP in the diet had significantly lower FI value during the period 37–40 week (Table 3). The inclusion of 0.1%SRP of GM laying hens significantly (P≤0.05) affected FI during the periods 33–36 and 29–40 weeks, GM laying hens fed 0.1%SRP in the diet had significantly higher FI values during these periods, this may be due to the increased EW in these treatments as mentioned above (Table 3).

The interaction effect had significantly affected FI during all periods studied (Table 3), GM laying hens fed 20%SBP with 0.1%SRP in the diet had significantly higher FI values during the periods 29–32, 33–36 and 29–40 weeks, while, GM laying hens fed 0.0%SBP with 0.0%SRP in the diet had significantly lower FI values during the same periods. Golden Montazah laying hens fed 20%SBP with 0.0%SRP in the diet had significantly higher FI value during the period from 37 to 40 weeks; however, GM laying hens fed 5%SBP with 0.0%SRP in the diet had significantly lower FI value during the same period.

The main effects of SBP% had significantly (P≤0.001) affected FCR, CPC and CCR during all studied periods, GM laying hens fed 20%SBP had significantly the worst FCR, CPC and CCR values during the periods 29–32, 33–36 and 29–40 weeks and GM laying hens fed 0.0%SBP in the diet had significantly the best FCR, CPC and CCR values during the same periods, differences among 0.0, 5, 10 and 15%SBP were not significant, GM laying hens fed 10%SBP in the diet had significantly the worst FCR, CPC and CCR values during the period 37–40 week, while, those fed 15%SBP in the diet had significantly the best FCR, CPC and CCR values during the same period (Table 4).

The inclusion of 0.1%SRP in the diet of GM laying hens significantly (P≤0.05) affected FCR, CPC and CCR over the period from 37 to 40 weeks, GM laying hens fed 0.1%SRP in the diet had significantly the worst values during this period (Table 4).

The interaction between SBP%×SRP% in the diet (treatment effect) had significantly affected FCR, CPC and CCR during the periods 29–32, 33–36 and 37 to 40 weeks (Table 4), GM laying hens fed 20%SBP with 0.1%SRP in the diet had significantly the worst FCR, CPC and CCR value during the periods 29–32 and 33–36 weeks, while, GM laying hens fed 0.0%SBP with 0.1%SRP in the diet had significantly the best FCR, CPC and CCR value during the same periods. Golden Montazah laying hens fed 10%SBP with 0.1%SRP in the diet had significantly the worst FCR, CPC and CCR value during the period from 37 to 40 weeks, but, GM laying hens fed 15%SBP with 0.0%SRP in the diet had significantly the best FCR, CPC and CCR value during the same period. Treatment effects had insignificantly affected FCR, CPC and CCR values over the period 29–40 weeks.

Similar results were stated by Emam and Abdel Wahed (2020) who reported that adding SBP at different levels to the diets of Gimmizah laying hens resulted in significant differences in EW, FI, CPC and CCR during the period 24 to 27 weeks of age. Gimmizah laying hens fed diets containing 0.0% SBP showed better CPC and CCR values, but, differences among 0, 5, 10, and 15% SBP were not statistically significant, but, those fed 20% SBP had the worst values of CPC and CCR (the highest values of EW and higher FI during the same period). Adding SBP in the diet caused significant differences in EW and EP; however, increasing the level of SBP from 0.0 to 15% had no significant difference on cumulative feed consumption (FC) of Hi-sex laying hens over the period 22-55 weeks (Almirall et al., 1997). While, El-Ghamry *et al.* (2003) found that increasing the level of SBP from 0.0 to 15% in the diet of Buffalo Brown laying hens had no significant effect on EP between 52 and 64 weeks of age. But, the researchers establish that FCR and feed efficiency worsened significantly with increasing SBP dietary supplementation from 10 to 15% compared to those fed 0.0%SBP, possibly due to increased SBP levels due to its high CF content.

Roberts *et al.* (2007) reported no significant effect of increasing dietary fiber in the diet of Hi-line W-36 hens on EP, EW, FC, or FCR during the period from 23 to 58 weeks of age, the use of 4%SBP resulted in higher egg albumin%, yolk%, shell%, and Haugh units (HU) values, however, reduced egg shell thickness (Nobakht and Hamedi, 2014). Moreover, Alagawany and Attia (2015) noted that no significant effects of dietary SBP increase on FI, FC, egg count, and EW was observed.

Regard to the SRP effect, Abou-Elkhair et al. (2018) stated that addition of 0.5% hot RP in layer diets enhanced the EW, EP rate, egg mass and FCR compared to the control during 32 to 40 weeks of age. Li et al. (2012) indicated that addition of dried RP and hot RP significantly improved EW. In this respect, Deli et al. (2001) reported that the improved EP rate of dried SRP-treated layers can be attributed to the great amount of carotenoids present in dried SRP, for example, anthraxanthin, capsanthin, zeaxanthin, capsorbin beta-cryptoxanthin, and beta-carotene, which are precursors of vitamin A. Furthermore, vitamin A supplementation exceeding the National Research Council recommendations showed no significant effect on the performance of laying hens under normal conditions (Lin et al., 2002). However, addition of paprika or RP showed no significant effect on FI (Abiodun et al., 2014), EW (Gurbuz et al., 2003; Abiodun et al., 2014 and Spasevski et al., 2017), FI, EM, EP and feed efficiency (Lokaewmanee et al., 2013), FI, FCR, EM, or EP (Rossi et al., 2015) with addition of sweet green pepper and FI, EW and EM (Saleh et al., 2021).

Levels of dried SRP had insignificant alterations on Silver Montazah layers performance during all experimental periods except FCR, EP rate, EM at 43-45 weeks of age and daily FI at 40-42 weeks, with significant effects on EW were observed during all periods studied except, the period from 40 to 42 weeks (Hassan et al., 2019).

Egg quality: Results obtained (Tables 5a, 5b and 5c) show the influence of using different levels of SBP with or without adding SRP in the diets of GM laying hens on egg quality characteristics.

The main effects of SBP% had insignificantly (P>0.05) affected albumen%, shape index%, yolk% and shell%, but, SBP% had significantly affected egg YC at 36 week, YI% at 36 week, 40 weeks and mean of three periods, shell thickness at 32 week, 40 week and mean of three periods and HU at 36 week and mean of three periods (Tables 5a, 5b and 5c).

Golden Montazah laying hens fed 0.0%SBP in the diet had significantly (P≤0.05) higher value of egg YC at 36 week, GM laying hens fed 20%SBP in the diet had significantly lower value of egg YC at the same age (Table 5b). Golden Montazah laying hens fed 0.0%SBP had significantly lower value of YI% at 36 weeks (P≤0.01), 40 weeks (P≤0.01) and mean of three periods (P≤0.001), GM laying hens fed 10%SBP in the diet had significantly higher value of YI% at 36 weeks and mean of three periods and GM laying hens fed 20%SBP in the diet had significantly higher value of YI% at 40 weeks (Table 5b). Golden Montazah laying hens fed on either 0.0% (32 week (P≤0.05)) or 10%SBP (40 week (P≤0.05) and the mean of three periods (P≤0.01)) had significantly higher value of shell thickness, respectively, while, those fed 20%SBP had significantly lower value of shell thickness at 32 week, 40 week and mean of three periods (Table 5c). Golden Montazah laying hens fed on 10%SBP had significantly higher value of HU at 36 weeks of age (P≤0.01) and mean of three periods (P≤0.001) and GM laying hens fed 0.0%SBP recorded significantly lower value of HU at same ages.(Table 5c).

The main effects of SRP% had insignificantly affected (P>0.05) albumen%, yolk% and shell%, but, SRP% had significantly affected shape index at 36 week, egg YC at 32 weeks, 36 weeks, 40 weeks and mean of three periods, YI% at mean of three periods, shell thickness at 40 weeks and HU at 36 weeks and mean of three periods (Tables 5a, 5b and 5c).

Golden Montazah laying hens fed 0.0%SRP in the diet had significantly lower values of shape index% (P≤0.05) at 36 week, egg YC (P≤0.001) at 32, 36, 40 weeks and mean of three periods, YI% (P≤0.05) at mean of three periods, shell thickness at 40 week, and HU at 36 weeks of age and mean of three periods, but, GM laying hens fed 0.1%SRP in the diet had significantly higher values of shape index, egg YC, YI%, shell thickness and HU at the same ages (Tables 5a, 5b and 5c).

The interaction between SBP%×SRP% in the diet (treatments effect) had significantly affected shape index at 36 week and mean of three periods, and egg YC at the mean of three periods, but, insignificantly (P>0.05) affected albumen%, yolk%, YI%, shell%, shell thickness and HU (Tables 5a, 5b and 5c).

Golden Montazah laying hens fed 5%SBP with 0.1%SRP in the diet had significantly higher value of shape index at 36 week and mean of three periods, but, GM laying hens fed 5%SBP with 0.0%SRP in the diet had significantly lower value at the same periods. Golden Montazah laying hens fed 0.0%SBP with 0.1%SRP and 20%SBP with 0.1%SRP in the diet had significantly higher value of egg YC at the mean of three periods, but, GM laying hens fed 5%SBP with 0.0%SRP and 20%SBP with 0.0%SRP in the diet had significantly lower value of egg YC at the same period.

In this respect, El-Ghamry et al. (2003) stated that feeding SBP at different levels (5-15%) over the period from 52 to 64 weeks of age did not significantly affect egg quality parameters except, for egg YC and shell thickness. They, also reported that increasing the proportion of SBP from 10 to 15% resulted in a decrease in egg YC. Also, studies have shown that feeding 4%SBP resulted in higher albumin, yolk, shell, and HU values, but, reduced eggshell thickness (Nobakht and Hamedi, 2014).

The highest YC values for eggs were determined in hens fed 2% RP, while the lowest values were recorded in hens fed barley and wheat-based diets (Shahsavari, 2014). Nevertheless, Gurbuz et al. (2003) reported that the highest egg YC values in groups fed maize-based diets with 3 and 4%RP. Previous studies have indicated improved egg YC after adding SRP or hot RP powder to layer diets (Moeini et al., 2013; Spasevski et al., 2017; Abou-Elkhair et al., 2018; Panaite et al., 2021 and Saleh et al., 2021), due to its high carotenoid content. Other studies have found that the egg YC of hens fed diet containing RP powder were redder, yellower, and darker in color than the yolks of hens fed control diet (Li et al., 2012 and Lokaewmanee et al., 2013).

It is known that the egg YC is primarily influenced by diet. In this respect, Colin et al. (2004) note that 0.1% paprika group had the higher egg YC score as compared to the control. This may be due to *Enterococci* stimulated gut acidity by producing lactic acid. This acidity altered villus height (Rolfe, 2000 and Patterson and Burkhoder, 2003) and promoted gut health by inhibiting pathogenic bacteria (Paul, et al., 2007). Increased villus height was shown to be due to hyperplasia (Khambualai et al., 2009). The researchers suggested that *Enterococcus* bacteria may have stimulated intestinal function and allowed for increased intestinal xanthophyll absorption, leading to enhance egg YC.

Results obtained herein are in harmony with previous studies (Abiodun et al., 2014; Shahsavari , 2015; Rossi et al., 2015; Oliveira et al., 2017; Abou-Elkhair et al., 2018 and Hassan et al., 2019), as they demonstrated that the egg YC of hens fed a natural colorant by dried sweet pepper (green or red) was more yellow than that of hens fed a standard diet. The use of natural paprika powder at a concentration of 0.4% in the diet of laying hens appears to be an effective means of sustainably increasing high-quality EP. Paprika is very important in improving egg YC and production performance (Saleh et al., 2021). Using natural dyes (paprika) in Lohmann-Brown layer diets significantly affected the redness of the yolk (Spasevski et al., 2017). Rowghanni et al. (2006) reported that the addition of 3%RP showed the highest significant improvement effects on egg YC value, while the addition of 0.5%RP ensured that the egg YC value of eggs was more preferred by consumers. Lokaewmanee et al. (2013) noted that using 0.5%RP in the layer diet did not significantly affect shell thickness and HU.

Supplementation of paprika to the diet of Lohmann Brown laying hens did not affect the weight of eggshell, yolk, and albumin (Spasevski et al., 2017), the weight of EW, yolk, albumen, and egg shell (Rowghanni et al., 2006), EW, albumen, yolk and eggshell weight (Panaite et al., 2021) by kapia pepper. Eggshell thickness was not affected by adding RP to the diet (Shahsavari, 2014). Interestingly, adding paprika colorants to the diet showed significant improvement effects on shell thickness, albumen and yolk width. Paprika supplementation did not affect egg length, width, weight, yolk height and weight, or shell weight, but, did decrease egg albumen weight and height (Saleh et al., 2021).

Economical and relative efficiency (EEf):

The effect of dietary treatments on the economical efficiency values are shown in Table (6). Golden Montazah laying hens fed 0.0%SBP with 0.1%SRP gave the best economical and relative efficiency values being 0.6061 and 165.24%, respectively, followed by hens fed 5%SBP with 0.0% SRP being, 0.5390 and 146.95%, respectively, then hens fed 15%SBP with 0.1%SRP, being, 0.4899 and 133.55%, respectively, followed by hens fed 15%SBP with 0.0% SRP being, 0.4345 and 118.46%, respectively, followed by hens fed 10%SBP with 0.0% SRP being, 0.3692 and 100.66%, respectively. But, hens fed 20%SBP with 0.1% SRP gave the worst economical and relative efficiency values being 0.1532 and 41.77%, respectively.

Our findings are partially corroborates with that of Emam and Abdel Wahed (2020) who reported that Gimmizah laying hens fed 5%SBP in the diet achieved the best values in terms of economical and relative efficiency, then hens fed 10%SBP as compared to hens fed 0.0%SBP, although, those fed 20%SBP had the lowest values over the total period (from 24-27 weeks of age). Also, over the period from 3 to 8 weeks of age Gimmizah chicks fed.

CONCLUSION

The results showed that the most economically effective level of SBP was obtained from the control diet, followed by those fed diet containing 5% SBP. Depending on market conditions and financial circumstances, this can reach 15% with or without the addition of 0.1% SRP to GM laying hens' diets without any negative impact on performance. This contributes to improve laying hens' production and reduced feed costs, especially given the unavailability of conventional feed ingredients, reducing imports and saving hard currency.

Table (1a): Composition of the experimental diets.

	Item, %	Level of sugar beet pulp%				
		0.0	**5.0**	**10.0**	**15.0**	**20.0**
Feed Ingredients	Yellow corn	60.61	58.41	52.61	46.86	41.04
	Sugar beet pulp, ground	0.00	5.00	10.00	15.00	20.00
	Soybean meal (44%CP[1])	23.47	24.01	24.18	24.33	24.49
	Wheat bran	3.00	0.00	0.00	0.00	0.00
	Calcium carbonate	9.40	9.30	9.20	9.10	9.01
	Sodium chloride	0.40	0.40	0.38	0.35	0.33
	Vit. and Min. premix[2]	0.30	0.30	0.30	0.30	0.30
	Dicalcium phosphate	1.57	1.60	1.62	1.63	1.65
	Vegetable oil (75% soybean oil and 25% sunflower oil)	1.16	0.89	1.62	2.34	3.08
	DL–Methionine	0.09	0.09	0.09	0.09	0.10
	Total	100.00	100.00	100.00	100.00	100.00

[1] Crude protein

[2] Each 3.0 Kg of the Vit. and Min. premix contains: Vit. A 10000000 IU; Vit. D3 2000000 IU; Vit. E 10000 IU; Vit. K3 1000 mg; Vit. B1 1000 mg; Vit. B2 5000 mg; Vit. B6 1500 mg; Vit. B12 10.0 mg; biotin 50.0 mg; folic acid 1000 mg; niacin 30000 mg; pantothenic acid 10000 mg; Zn 50000 mg; Cu 4000 mg; Fe 30000 mg; Co 100 mg; Se 100 mg; I 300 mg; Mn 60000 mg, and complete to 3.0 Kg by calcium carbonate

Table (1b): Calculated analysis of the experimental diets.

Item, %		Level of sugar beet pulp%				
		0.0	5.0	10.0	15.0	20.0
Calculated analysis[1]:						
Protein and amino acids	Crude protein	16.00	16.00	16.00	16.00	16.00
	Lysine	0.81	0.83	0.85	0.88	0.90
	Methionine	0.35	0.35	0.35	0.35	0.36
	Methionine+Cystine	0.62	0.62	0.62	0.62	0.62
	Arginine	1.00	1.00	1.00	1.00	1.00
	Threonine	0.60	0.61	0.63	0.64	0.65
	Valine	0.74	0.76	0.77	0.78	0.80
Crude fiber and fiber fractions	Crude fiber	3.31	3.92	4.75	5.59	6.42
	Neutral detergent fiber (NDF)	10.20	11.00	12.66	14.33	15.99
	Acid detergent fiber(ADF)	4.29	5.06	6.08	7.11	8.13
	Acid detergent lignin	0.50	0.58	0.75	0.92	1.09
	Hemicelluloses (NDF – ADF)	5.91	5.94	6.58	7.22	7.86
	Celluloses	3.79	4.48	5.33	6.19	7.04
	Lignin	0.79	0.84	0.95	1.06	1.16
Fat	Ether extract	3.74	3.33	3.87	4.40	4.95
	Linoleic acid	2.09	1.88	2.17	2.45	2.74
Minerals	Calcium	4.00	4.00	4.00	4.00	4.01
	Available phosphorus	0.40	0.40	0.40	0.40	0.40
	Potassium	0.68	0.68	0.69	0.71	0.73
	Sodium	0.18	0.18	0.18	0.18	0.18
	Chloride	0.28	0.28	0.27	0.26	0.25
Betaine		0.03	0.03	0.05	0.07	0.09
ME, kcal./Kg		2700.5	2700.3	2700.3	2700.5	2700.9
Cost (£.E./ton)[2]		15132	14765	14694	14613	14562
Relative cost[3]		100.00	97.577	97.107	96.600	96.234

[1] According to NRC (1994) and Emam and Abdel Wahed (2020).
[2] According to the local market price at the experimental time.
[3] Assuming the price of the control group equal 100.

Table (2): Effect of using different levels of sugar beet pulp (SBP) supplemented with sweet red pepper (SRP) in the diets of Golden Montazah laying hens on average egg weight, g (EW) and egg number/hen (EN).

Items		EW, g				EN			
		Age period (weeks)				Age period (weeks)			
		29-32	**33-36**	**37-40**	**29-40**	**29-32**	**33-36**	**37-40**	**29-40**
Level of SBP%									
0		36.21^{d}	40.95^{bc}	43.42^{c}	40.19^{b}	12.67	13.48	10.22^{ab}	36.37
5		38.52^{b}	42.35^{a}	45.56^{a}	42.14^{a}	11.61	13.26	8.55^{bc}	33.43
10		37.48^{c}	41.33^{b}	43.67^{bc}	40.83^{b}	13.73	14.15	7.65^{c}	35.53
15		37.54^{c}	40.49^{c}	44.13^{bc}	40.72^{b}	12.12	14.70	11.65^{a}	38.47
20		39.65^{a}	42.21^{a}	44.61^{ab}	42.16^{a}	11.15	12.87	10.03^{ab}	34.06
SEM[1]		0.19	0.23	0.31	0.21	0.88	0.72	0.56	2.02
P-value		<0.001	<0.001	0.001	<0.001	0.306	0.508	<0.001	0.590
SRP%									
0.0		37.41^{b}	40.99^{b}	44.14	40.85^{b}	11.84	13.84	9.98	35.65
0.1		38.35^{a}	41.94^{a}	44.41	41.57^{a}	12.68	13.56	9.26	35.49
SEM		0.12	0.15	0.19	0.13	0.56	0.45	0.36	1.28
P-value		<0.001	<0.001	0.378	0.001	0.335	0.692	0.198	0.936
Treatments effect (SBP%* SRP%)									
0	0.0	35.32^{f}	40.28^{d}	42.51^{d}	39.37^{e}	11.22	11.80	8.89^{bcd}	31.91
	0.1	37.10^{e}	41.62^{bc}	44.34^{bc}	41.02^{bc}	14.11	15.17	11.56^{ab}	40.83
5	0.0	39.29^{b}	42.95^{a}	46.91^{a}	43.05^{a}	12.50	14.33	8.83^{bcd}	35.67
	0.1	37.75^{de}	41.74^{bc}	44.22^{bc}	41.24^{bc}	10.73	12.20	8.27^{cd}	31.20
10	0.0	36.03^{f}	40.09^{d}	43.11^{cd}	39.75^{de}	12.44	14.00	8.94^{bcd}	35.38
	0.1	38.93^{bc}	42.56^{ab}	44.23^{bc}	41.91^{b}	15.03	14.30	6.36^{d}	35.69
15	0.0	38.05^{d}	40.51^{d}	44.48^{bc}	41.02^{bc}	11.83	15.91	12.45^{a}	40.20
	0.1	37.03^{e}	40.47^{d}	43.78^{cd}	40.42^{cd}	12.40	13.50	10.84^{abc}	36.74
20	0.0	38.36^{cd}	41.10^{cd}	43.72^{cd}	41.06^{bc}	11.19	13.14	10.78^{abc}	35.11
	0.1	40.95^{a}	43.33^{a}	45.50^{b}	43.26^{a}	11.11	12.61	9.28^{bc}	33.00
SEM		0.26	0.33	0.43	0.42	1.24	1.01	0.79	2.86
P-value		<0.001	<0.001	<0.001	<0.001	0.410	0.077	0.022	0.190

[a–f] Means in a column, at each item, with different superscripts differ significantly ($P \leq 0.05$). [1] Pooled SEM

Table (3): Effect of using different levels of sugar beet pulp (SBP) supplemented with sweet red pepper (SRP) in the diets of Golden Montazah laying hens on egg production (EP%) and daily feed intake (FI, g)

Items		EP%				FI, (g/hen/day)			
		Age period (weeks)				Age period (weeks)			
		29-32	33-36	37-40	29-40	29-32	33-36	37-40	29-40
Level of SBP%									
0		45.24	48.15	36.51^{ab}	43.30	67.99^{c}	79.76^{c}	82.14^{c}	76.63^{d}
5		41.48	47.37	30.55^{bc}	39.80	70.17^{c}	86.79^{b}	79.26^{c}	78.74^{c}
10		49.04	50.54	27.31^{c}	42.30	86.22^{a}	92.86^{a}	77.08^{d}	85.39^{b}
15		43.28	52.52	41.60^{a}	45.80	80.87^{ab}	89.61^{b}	86.72^{b}	85.73^{b}
20		39.83	45.98	35.81^{ab}	40.54	88.29^{a}	95.54^{a}	90.34^{a}	91.39^{a}
SEM[1]		3.13	2.56	2.01	2.41	1.85	0.95	1.26	1.03
P-value		0.306	0.508	<0.001	0.590	<0.001	<0.001	<0.001	<0.001
SRP%									
0.0		42.28	49.41	35.64	42.44	77.97	87.75^{b}	81.93	82.55^{b}
0.1		45.27	48.41	33.07	42.25	79.45	90.07^{a}	84.29	84.60^{a}
SEM		1.98	1.62	1.27	1.52	1.17	0.60	0.80	0.65
P-value		0.335	0.692	0.198	0.936	0.420	0.016	0.062	0.047
Treatments effect (SBP%* SRP%)									
0	0.0	40.08	42.13	31.75^{bcd}	37.99	66.63^{c}	75.60^{e}	78.17^{d}	73.47^{e}
	0.1	50.40	54.17	41.27^{ab}	48.61	69.35^{c}	83.93^{d}	86.11^{b}	79.79^{d}
5	0.0	44.64	51.19	31.55^{bcd}	42.46	67.86^{c}	82.14^{d}	74.26^{d}	74.75^{e}
	0.1	38.31	43.56	29.55^{cd}	37.14	72.48^{c}	91.43^{c}	84.27^{bc}	82.73^{cd}
10	0.0	44.42	50.00	31.92^{bcd}	42.11	83.04^{b}	92.86^{bc}	75.33^{d}	83.74^{cd}
	0.1	53.67	51.08	22.70^{d}	42.49	89.41^{ab}	92.86^{bc}	78.83^{cd}	87.03^{bc}
15	0.0	42.26	56.82	44.48^{a}	47.85	88.10^{ab}	97.08^{ab}	88.80^{ab}	91.32^{ab}
	0.1	44.30	48.21	38.72^{abc}	43.74	73.64^{c}	82.14^{d}	84.65^{bc}	80.14^{d}
20	0.0	39.98	46.92	38.49^{abc}	41.80	84.23^{ab}	91.07^{c}	93.08^{a}	89.46^{ab}
	0.1	39.68	45.04	33.13^{bc}	39.29	92.36^{a}	100.0^{a}	87.60^{ab}	93.32^{a}
SEM		4.43	3.62	2.83	3.40	2.62	1.34	1.78	1.45
P-value		0.410	0.077	0.022	0.190	0.004	<0.001	<0.001	<0.001

$^{a–e}$ Means in a column, at each item, with different superscripts differ significantly ($P \leq 0.05$). [1]Pooled SEM

Table 4: Effect of using different levels of sugar beet pulp (SBP) supplemented with sweet red pepper (SRP) in the diets of Golden Montazah laying hens on feed conversion ratio (FCR), crude protein conversion (CPC) and caloric conversion ratio (CCR).

Items		FCR (g feed/g egg mass)				CPC				CCR			
		Age period (weeks)				Age period (weeks)				Age period (weeks)			
		29-32	33-36	37-40	29-40	29-32	33-36	37-40	29-40	29-32	33-36	37-40	29-40
Level of SBP%													
0		4.30^{b}	4.15^{b}	5.50^{b}	4.65^{b}	0.81^{b}	0.74^{b}	0.92^{bc}	0.82^{b}	12.35^{b}	11.54^{b}	14.88^{bc}	12.92^{b}
5		4.44^{b}	4.40^{ab}	5.83^{ab}	4.89^{ab}	0.84^{b}	0.79^{b}	0.99^{ab}	0.88^{ab}	12.89^{b}	12.31^{ab}	16.04^{ab}	13.74^{ab}
10		4.84^{b}	4.48^{ab}	6.85^{a}	5.39^{ab}	0.92^{b}	0.81^{ab}	1.16^{a}	0.96^{ab}	14.05^{b}	12.55^{ab}	18.84^{a}	15.15^{ab}
15		5.17^{b}	4.28^{b}	4.75^{c}	4.73^{b}	0.98^{b}	0.77^{b}	0.81^{c}	0.85^{b}	14.99^{b}	11.99^{b}	13.07^{c}	13.35^{b}
20		6.25^{a}	5.45^{a}	6.00^{ab}	5.90^{a}	1.19^{a}	0.98^{a}	1.02^{ab}	1.06^{a}	18.12^{a}	15.25^{a}	16.51^{ab}	16.63^{a}
SEM[1]		0.32	0.28	0.31	0.28	0.06	0.05	0.05	0.05	0.93	0.78	0.88	0.81
P-value		0.001	0.017	0.002	0.021	0.001	0.016	0.002	0.017	0.001	0.016	0.002	0.017
SRP%													
0.0		5.04	4.39	5.41^{b}	4.95	0.95	0.79	0.91^{b}	0.89	14.57	12.27	14.77^{b}	13.87
0.1		4.96	4.71	6.17^{a}	5.28	0.94	0.85	1.05^{a}	0.95	14.39	13.19	16.96^{a}	14.85
SEM		0.20	0.18	0.20	0.18	0.04	0.03	0.03	0.03	0.59	0.49	0.55	0.51
P-value		0.802	0.250	0.017	0.236	0.847	0.234	0.014	0.232	0.847	0.234	0.014	0.221
Treatments effect (SBP%* SRP%)													
0	0.0	4.87^{bcd}	4.57^{b}	6.06^{bcd}	5.16	0.91^{bcd}	0.81^{b}	1.00^{bcd}	0.91	13.85^{bcd}	12.63^{b}	16.16^{bcd}	14.21
	0.1	3.74^{d}	3.73^{b}	4.94^{cd}	4.14	0.71^{d}	0.67^{b}	0.84^{cd}	0.74	10.84^{d}	10.44^{b}	13.59^{cd}	11.63
5	0.0	3.87^{cd}	3.74^{b}	5.02^{cd}	4.21	0.74^{cd}	0.67^{b}	0.85^{cd}	0.75	11.22^{cd}	10.46^{b}	13.80^{cd}	11.83
	0.1	5.02^{bcd}	5.05^{ab}	6.65^{ab}	5.57	0.95^{bcd}	0.91^{ab}	1.13^{ab}	1.00	14.55^{bcd}	14.15^{ab}	18.28^{ab}	15.66
10	0.0	5.34^{abcd}	4.65^{b}	5.81^{bcd}	5.26	1.02^{abcd}	0.84^{b}	0.99^{bcd}	0.95	15.49^{abcd}	13.01^{b}	15.97^{bcd}	14.82
	0.1	4.35^{bcd}	4.32^{b}	7.89^{a}	5.52	0.83^{bcd}	0.78^{b}	1.34^{a}	0.98	12.61^{bcd}	12.10^{b}	21.70^{a}	15.47
15	0.0	5.48^{abc}	4.22^{b}	4.49^{d}	4.73	1.04^{abc}	0.76^{b}	0.76^{d}	0.85	15.89^{abc}	11.81^{b}	12.34^{d}	13.35
	0.1	4.86^{bcd}	4.35^{b}	5.02^{cd}	4.74	0.92^{bcd}	0.78^{b}	0.85^{cd}	0.85	14.09^{bcd}	12.17^{b}	13.80^{cd}	13.35
20	0.0	5.65^{ab}	4.80^{b}	5.66^{bcd}	5.37	1.07^{ab}	0.86^{b}	0.96^{bcd}	0.97	16.39^{ab}	13.43^{b}	15.57^{bcd}	15.13
	0.1	6.85^{a}	6.10^{a}	6.34^{bc}	6.43	1.30^{a}	1.10^{a}	1.08^{bc}	1.16	19.86^{a}	17.07^{a}	17.45^{bc}	18.13
SEM		0.45	0.39	0.44	0.40	0.09	0.07	0.08	0.07	1.31	1.10	1.24	1.14
P-value		0.032	0.038	0.011	0.059	0.039	0.045	0.022	0.083	0.039	0.045	0.022	0.083

$^{a–d}$ Means in a column, at each item, with different superscripts differ significantly ($P \leq 0.05$). [1] Pooled SEM

Table (5a): Effect of using different levels of sugar beet pulp (SBP) supplemented with sweet red pepper (SRP) in the diets of Golden Montazah laying hens on albumen and shape index%

Items		**Albumen%**				**Shape index%**			
		Age (weeks)			**Mean**	**Age (weeks)**			**Mean**
		32	**36**	**40**		**32**	**36**	**40**	
Level of SBP%									
0		64.38	59.96	59.70	61.35	77.52	75.75	75.80	76.35
5		63.45	60.20	59.86	61.17	78.15	78.12	75.93	77.40
10		63.44	62.76	60.36	62.19	77.84	75.53	75.62	76.33
15		63.43	61.79	59.67	61.63	77.25	77.56	76.53	77.12
20		62.35	60.91	59.91	61.06	77.22	77.62	74.39	76.41
SEM[1]		0.90	0.89	1.02	0.52	1.03	1.34	0.915	0.67
P-value		0.638	0.169	0.990	0.558	0.962	0.538	0.576	0.696
SRP%									
0.0		63.42	60.66	59.65	61.24	77.83	75.64[b]	75.46	76.31
0.1		63.40	61.59	60.16	61.71	77.37	78.20[a]	75.85	77.14
SEM		0.57	0.56	0.64	0.33	0.65	0.846	0.579	0.423
P-value		0.978	0.247	0.578	0.312	0.626	0.038	0.645	0.172
Treatments effect (SBP%* SRP%)									
0	0.0	62.27	60.33	60.20	60.93	77.31	76.64[bc]	76.93	76.96[ab]
	0.1	66.49	59.59	59.20	61.76	77.73	74.85[bc]	74.67	75.75[b]
5	0.0	64.48	59.97	59.50	61.32	78.08	73.01[c]	74.07	75.05[b]
	0.1	62.41	60.43	60.23	61.02	78.22	83.23[a]	77.79	79.75[a]
10	0.0	63.31	62.03	58.44	61.26	78.19	75.54[bc]	75.11	76.28[b]
	0.1	63.57	63.49	62.27	63.11	77.49	75.52[bc]	76.14	76.38[b]
15	0.0	64.86	60.70	60.42	61.99	78.44	77.27[bc]	75.54	77.08[ab]
	0.1	62.00	62.88	58.92	61.27	76.08	77.86[abc]	77.52	77.15[ab]
20	0.0	62.18	60.25	59.66	60.70	77.10	75.71[bc]	75.69	76.16[b]
	0.1	62.52	61.56	60.16	61.41	77.34	79.54[ab]	73.11	76.66[b]
SEM		1.27	1.26	1.44	0.73	1.45	1.89	1.29	0.947
P-value		0.071	0.810	0.394	0.443	0.868	0.025	0.083	0.037

[a–c] Means in a column, at each item, with different superscripts differ significantly (P≤0.05).
[1] Pooled SEM

Table (5b): Effect of using different levels of sugar beet pulp (SBP) supplemented with sweet red pepper (SRP) in the diets of Golden Montazah laying hens on yolk%, yolk color and yolk index%.

Items		Yolk%				Yolk color				Yolk index%			
		Age (weeks)			Mean	Age (weeks)			Mean	Age (weeks)			Mean
		32	36	40		32	36	40		32	36	40	
Level of SBP%													
0		27.83	30.04	30.86	29.58	7.90	9.70^{a}	9.80	9.13	44.76	48.36^{b}	50.98^{c}	48.04^{b}
5		28.66	29.86	30.94	29.82	7.70	8.40^{b}	9.70	8.60	46.25	48.79^{b}	51.65^{c}	48.90^{b}
10		27.51	27.47	29.34	28.11	7.30	9.10^{ab}	9.30	8.57	46.45	54.12^{a}	54.82^{ab}	51.79^{a}
15		28.78	27.85	30.57	29.07	7.80	9.00^{ab}	9.90	8.90	46.22	53.14^{a}	53.56^{bc}	50.98^{a}
20		29.86	28.97	30.32	29.72	8.40	8.00^{b}	9.50	8.63	47.03	49.05^{b}	56.68^{a}	50.92^{a}
SEM[1]		0.84	0.86	0.85	0.46	0.39	0.37	0.44	0.21	1.03	1.28	1.03	0.55
P-value		0.324	0.147	0.679	0.072	0.412	0.025	0.874	0.286	0.626	0.004	0.002	<0.001
SRP%													
0.0		28.80	29.35	30.71	29.62	7.04^{b}	7.68^{b}	8.68^{b}	7.80^{b}	45.53	50.37	52.74	49.55^{b}
0.1		28.26	28.32	30.11	28.90	8.60^{a}	10.00^{a}	10.60^{a}	9.73^{a}	46.76	51.01	54.34	50.71^{a}
SEM		0.53	0.55	0.54	0.29	0.25	0.24	0.28	0.14	0.65	0.81	0.65	0.35
P-value		0.470	0.189	0.432	0.087	<0.001	<0.001	<0.001	<0.001	0.189	0.580	0.088	0.023
Treatments effect (SBP%* SRP%)													
0	0.0	29.14	29.87	30.00	29.67	7.40	8.60	8.80	8.27^{c}	43.98	50.04	49.17	47.73
	0.1	26.53	30.21	31.73	29.49	8.40	10.80	10.80	10.0^{a}	45.55	46.69	52.80	48.34
5	0.0	28.54	30.31	31.26	30.03	7.00	6.40	8.40	7.27^{d}	47.09	45.57	52.33	48.33
	0.1	28.79	29.41	30.63	29.61	8.40	10.40	11.00	9.93^{a}	45.41	52.00	50.98	49.47
10	0.0	27.83	28.44	31.29	29.19	6.60	8.40	8.00	7.67^{cd}	45.20	54.68	55.80	51.90
	0.1	27.19	26.50	27.40	27.03	8.00	9.80	10.60	9.47^{a}	47.69	53.56	53.83	51.69
15	0.0	28.70	28.94	29.84	29.16	7.60	8.40	9.60	8.53^{bc}	44.87	53.85	52.43	50.38
	0.1	28.86	26.76	31.30	28.97	8.00	9.60	10.20	9.27^{ab}	47.58	52.43	54.70	51.57
20	0.0	29.81	29.20	31.15	30.05	6.60	6.60	8.60	7.27^{d}	46.49	47.72	53.95	49.39
	0.1	29.91	28.74	29.48	29.38	10.20	9.40	10.40	10.0^{a}	47.57	50.38	59.41	52.46
SEM		1.18	1.22	1.20	0.65	0.56	0.53	0.62	0.30	1.46	1.81	1.45	0.78
P-value		0.722	0.830	0.131	0.532	0.069	0.071	0.485	0.012	0.581	0.073	0.065	0.327

$^{a–d}$ Means in a column , at each item, with different superscripts differ significantly ($P \leq 0.05$). [1] Pooled SEM

Table (5c): Effect of using different levels of sugar beet pulp (SBP) supplemented with sweet red pepper (SRP) in the diets of Golden Montazah laying hens Shell%, Shell thickness, mm and Haugh unit.

Items		Shell%				Shell thickness, mm				Haugh unit			
		Age (weeks)			Mean	Age (weeks)			Mean	Age (weeks)			Mean
		32	36	40		32	36	40		32	36	40	
Level of SBP%													
0		7.79	9.99	9.43	9.07	0.39^{a}	0.42	0.39^{ab}	0.40^{b}	58.36	55.23^{c}	55.85	56.48^{c}
5		7.89	9.94	9.19	9.01	0.35^{bc}	0.43	0.38^{b}	0.39^{b}	59.41	56.33^{bc}	56.81	57.52^{bc}
10		9.05	9.77	10.30	9.71	0.38^{ab}	0.45	0.44^{a}	0.42^{a}	60.14	59.07^{a}	58.07	59.10^{a}
15		7.79	10.36	9.76	9.30	0.35^{bc}	0.45	0.39^{ab}	0.40^{b}	59.44	57.87^{ab}	58.19	58.50^{ab}
20		7.79	10.12	9.77	9.23	0.34^{c}	0.45	0.35^{b}	0.38^{b}	58.18	57.93^{ab}	57.54	57.89^{b}
SEM[1]		0.56	0.35	0.49	0.28	0.01	0.01	0.02	0.01	0.76	0.67	0.70	0.38
P-value		0.430	0.812	0.573	0.439	0.025	0.251	0.032	0.010	0.344	0.002	0.124	<0.001
SRP%													
0.0		7.78	9.99	9.65	9.14	0.36	0.44	0.37^{b}	0.39	59.01	56.46^{b}	56.76	57.41^{b}
0.1		8.35	10.09	9.74	9.39	0.36	0.44	0.41^{a}	0.40	59.20	58.11^{a}	57.83	58.38^{a}
SEM		0.35	0.22	0.31	0.18	0.00	0.01	0.01	0.01	0.48	0.43	0.44	0.24
P-value		0.263	0.763	0.836	0.321	0.683	0.957	0.043	0.088	0.780	0.009	0.097	0.007
Treatments effect (SBP%* SRP%)													
0	0.0	8.60	9.79	9.80	9.40	0.40	0.42	0.41	0.41	57.04	54.72	56.16	55.97
	0.1	6.98	10.19	9.07	8.75	0.38	0.42	0.37	0.39	59.68	55.74	55.54	56.99
5	0.0	6.98	9.72	9.24	8.65	0.34	0.43	0.36	0.38	58.67	55.11	55.74	56.51
	0.1	8.81	10.16	9.14	9.37	0.35	0.44	0.40	0.39	60.16	57.54	57.89	58.53
10	0.0	8.85	9.53	10.26	9.55	0.38	0.44	0.42	0.41	60.59	57.90	56.65	58.38
	0.1	9.24	10.01	10.33	9.86	0.37	0.46	0.45	0.43	59.70	60.25	59.50	59.82
15	0.0	6.45	10.36	9.73	8.85	0.35	0.46	0.38	0.40	59.09	56.95	58.94	58.33
	0.1	9.14	10.36	9.78	9.76	0.35	0.44	0.40	0.40	59.78	58.79	57.44	58.67
20	0.0	8.02	10.55	9.19	9.25	0.31	0.46	0.30	0.35	59.67	57.64	56.33	57.88
	0.1	7.57	9.70	10.36	9.21	0.36	0.45	0.41	0.41	56.69	58.22	58.75	57.89
SEM		0.79	0.50	0.69	0.40	0.02	0.02	0.03	0.01	1.08	0.95	0.99	0.54
P-value		0.068	0.635	0.738	0.305	0.366	0.924	0.064	0.060	0.105	0.828	0.114	0.348

[a–c] Means in a column , at each item, with different superscripts differ significantly ($P \leq 0.05$). [1] Pooled SEM

Table(6): Effect of using different levels of sugar beet pulp (SBP) supplemented with sweet red pepper (SRP) in the diets of Golden Montazah laying hens on economical efficiency during the period from 29 to 40 weeks of age.

Items	**Level of SBP%**									
	0.00		**5.00**		**10.00**		**15.00**		**20.00**	
SRP %	0.00	0.10	0.00	0.10	0.00	0.10	0.00	0.10	0.00	0.10
a	31.91	40.83	35.67	31.20	35.38	35.69	40.20	36.74	35.11	33.00
b	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
c = a × b	127.64	163.32	142.68	124.80	141.52	142.76	160.80	146.96	140.44	132.00
d	73.47	79.79	74.75	82.73	83.74	87.03	91.32	80.14	89.46	93.32
e	6.171	6.702	6.279	6.949	7.034	7.311	7.671	6.732	7.515	7.839
f	15.132	15.172	14.765	14.805	14.694	14.734	14.613	14.653	14.562	14.602
g = e × f	93.39	101.69	92.709	102.88	103.36	107.71	112.09	98.64	109.43	114.46
h = c - g	34.253	61.632	49.971	21.915	38.160	35.047	48.705	48.320	31.012	17.537
E.E.f. = h / g	0.3668	0.6061	0.5390	0.2130	0.3692	0.3254	0.4345	0.4899	0.2834	0.1532
Relative (E.E.f.)	100.00	165.24	146.95	58.07	100.66	88.71	118.46	133.55	77.27	41.77

a ……. egg number/hen.
b …… price/ egg (L.E.), according to the local market price at the experimental time.
c ……. total price of eggs /hen (L.E.).
d……..daily feed intake (g).
e……... total feed intake/hen, kg = (FI (g/hen/day) /1000) X 84 days (Experiment period, days).
f……..price/ Kg feed (L.E.), based on average price of diets during the experimental time.
g……..total feed cost/hen (L.E.)
h……..net revenue / hen (L.E.)
E.E.f. …..economical efficiency(net revenue per unit feed cost).
Relative (E.E.f.)……assuming that economical efficiency of the control groups equals 100.

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الملخص العربي

تأثير استخدام مستويات مختلفة من تفل بنجر السكر المضاف إليه الفلفل الأحمر الحلو في العليقة على أداء دجاج المنتزه الذهبي البياض

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استهدف البحث دراسة تأثير إضافة مستويات مختلفة من لب بنجر السكر المضاف إليه مسحوق الفلفل الأحمر الحلو (البابريكا) في العلائق على أداء دجاج المنتزه الذهبي البياض. بدأت التجربة في عمر 197 يومًا تسبقها فترة اقلمه مدتها 28 يومًا وانتهت عند عمر 280 يومًا. قسمت 360 دجاجة في عمر 29 أسبوعًا عشوائياً بالتساوي إلى 10 معاملات (0.0 ، 5.0 ، 10.0 ، 15.0 و 20.0% من تفل بنجر السكر كل منها بدون أو مع 0.1% من الفلفل الحلو)،أي 36 دجاجة/3 مكررات/12 دجاجة لكل مكرر.
أظهرت جميع المعاملات الغذائية (لب بنجر السكر% × الفلفل الأحمر الحلو%) تحسنًا ملحوظًا في وزن البيض خلال الفترة من 29 إلى 40 أسبوعًا. وسجلت الدجاجات التي غذّت على 20% لب بنجر السكر مع 0.1% الفلفل الأحمر الحلو ارتفاعًا ملحوظًا في وزن البيض واستهلاك العلف خلال هذه الفترة، بينما انخفضت قيم استهلاك العلف بشكل ملحوظ لدى الدجاجات التي غذّت على عليقة المقارنة. إلا أن هذا التأثير لم يكن ذا دلالة إحصائية على عدد البيض، أو إنتاجه، أو معامل تحويل العلف، أو معامل تحويل البروتين الخام، أو كفاءة تحويل الطاقة خلال نفس الفترة.
لم يكن للمعاملات الغذائية اي تأثيرًا على نسبة الألبومين، نسبة الصفار، دليل الصفار، نسبة القشرة، سمك القشرة، وقيمة وحدات هاو، بينما أثرت معنوياً على دليل الشكل ولون الصفا في متوسط الثلاث فترات (32، 36، و40 أسبوعًا). سجلت الدجاجات الاتي غذيت على 0.0% لب بنجر السكر مع 0.1% من الفلفل الأحمر الحلو و20.0% لب بنجر السكر مع 0.1% الفلفل الأحمر الحلو أعلى قيمة لـلون الصفار في متوسط الثلاث فترات، بينما أظهرت الدجاجات التي غذيت على 5.0% لب بنجر السكر مع 0.0% الفلفل الأحمر الحلو و20.0% لب بنجر السكر مع 0.0% الفلفل الأحمر الحلو أقل قيمة.
سجلت الدجاجات التي غذّيت على 20.0% لب بنجر السكر مع 0.0% الفلفل الأحمر الحلو اعلى قيمة في نسبة القانصة، وطول الأعور، والأمعاء الدقيقة. في المقابل، سجلت الدجاجات التي غذّيت على علائق المقارنة اقل قيمة في نسبة القانصة، بينما سجلت الدجاجات التي غذّيت على 20.0% لب بنجر السكر مع 0.1% الفلفل الأحمر الحلو أعلى قيمة لطول الأمعاء الغليظة.
الاستنتاج: اظهرت النتائج أن أعلى مستوى كفاءة اقتصادية ونسبية لـ SBP كان لعليقة المقارنة، يليه العلائق التي تحتوي على 5% SBP. اعتمادا على ظروف السوق والظروف المالية، يمكن أن يصل هذا المستوى إلى 15% مع أو بدون إضافة 0.1% SRP إلى علائق دجاج المنتزه الذهبي البياض، دون أي تأثير سلبي على الأداء.