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Partial Replacment of Yellow Maize Grains by Sun-Dried Orange Pulp in Summer Rations of Lactating Buffalo

Mohammed H. Bakr[1], Sabbah M. Allam[1], Eman H. Elsabaawy[2], Ebtehal H. Al-Adawy[1*] and Fatma Abou-Hashim[1]

[1]*Animal Production Department, Faculty of Agriculture, Cairo University,12613 Giza, Egypt.*

[2]*Animal Production Department, Agricultural and Biological Research Institute, National Research Centre, 12622, Cairo, Egypt.*

Abstract

TO STUDY the partial replacement of yellow maize grains (YMG) with sun- dried orange pulp (SDOP) during the summer months , 27 Egyptian lactating buffaloes (body weight : 600 ± 50 kg; parity: 1st to 4th) were allotted randomly to 3 experimental groups. Investigations were done on specific blood parameters, feed consumption, nutrient digestibility, milk composition and yield, feed and economic efficiency. Sun-dried orange pulp replaced YMG at 0 Control (R1), 30%SDOP (R2), and 60% SDOP (R3). Comparing to Control, the dry matter intake (DMI) in 30%SDOP and 60%SDOP was decreased by 0.63 and 0.83 kg, respectively. Raising the replacement level of SDOP led to an enhancement in the digestibility of crude fiber (CF; $P < 0.05$), while the rest of nutrients remained unchanged except for crude protein (CP) and digestible CP, which dramatically reduced. Statistically, no significant variations were observed across all blood parameters analyzed ($P > 0.05$). Concerning fat-corrected milk (FCM) and daily milk yield (DMY), no significant changes ($P > 0.05$) were observed, however. Compared to Control, the cost of concentrate feed mixture (CFM; LE/kg) was lower by 6.6% and 13.17%, meanwhile, feed effeciency was improved by 16.67 and 4.17% in 30% SDOP and 60% SDOP, respectively, which was strongly reflected in reducing feeding cost to produce 1 kg of milk and enhancing feed and economic efficiency. The results of the study imply that feed producers and ruminant holders may be able to reduce feeding expenses without affecting neither animal welfare nor performance in a way that is still profitable. Moreover, Egyptian buffalo is ideal for Egypt's summer climate.

Keywords: Buffalo Feeding, Sun Dried Orange Pulp, Heat Stress, feed digestibility and Economic Efficiency.

Introduction

Total digestible nutrients (TDN) an estimated 4.2 million tons are needed annually for animal production systems in Egypt; however, the amount of feed that is needed and what is available differs significantly [1]. This gap is seen to pose a serious threat to Egypt's animal husbandry activities, especially in the area of concentrated feedstuffs.

Grain maize accounts for a substantial portion of the CFM for livestock (around 0.50 ± 0.10) [2]. Egypt imported over than 11 million tons of corn grains in 2021–2022 compared to 64,000 tons in 1969, a 172-double increase that required a substantial amount of foreign currency annually (roughly \$3 billion in 2022) beside the ongoing increase in concentrate feed ingredient costs [3]. However, the 2021/22 season saw a decrease in grain imports due to Russia and Ukraine ongoing conflict. Hence, shipping disturbance occurred in the Black Sea and inactive ports in Ukraine, which consequently prompted a sharp increase in grain prices [4]. These days, feeding dairy ruminants a grain-based diet doesn't seem like a cost-effective approach and this is because of the low price of milk and high feed cost [5]. So that, it is inevitable to find a new feed strategies to reduce the proportion of grains used in livestock feeding to reduce feed costs without sacrificing the animals' health or performance.

*Corresponding author: Ebtehal Habib Al-Adawy, E-mail: ebtehalaladawy26.me@gmail.com, Tel.: 01007656831
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Heat stress (HS) is a major contributor to summertime losses for farms raising dairy and meat because it impairs animal immunity, growth rates, milk production, and reproductive efficiency [6]. From this perspective, domestic ruminants are less susceptible to HS than buffaloes [7].

Wind speed, atmospheric pressure, ambient temperature (AM), and relative humidity (RH) are environment-related elements that influence livestock and cause HS [8]. The detrimental effects of HS on cattle could be scaled by the Temperature Humidity Index (THI), where a decrease in milk production and fertility is linked to a high THI of 75 or higher [9-10]. Omran et al. [11] suggest that feed supplements may reduce the climate sensitivity of buffaloes.

Moreover, the occurrence of global warming highlights the necessity of locating alternative feed sources for cattle raised in heat-stress environments that either lowering heat increment produced from metabolism processes or supplementation of specific additives with alleviating heat stress properties, such as vitamin E and C, or other antioxidants [12].

Moreover, 48.6 million tons of oranges were expected to be produced worldwide in 2020–2021 with 50–60% of the processed fruit may be discarded. Additionally, Egypt is recognized as one of the top manufacturing and exporting nations [13-14].

Excellent nonconventional feeds for ruminants could be obtained as orange by-products such as DOP, citrus silage, citrus molasses and liquor of citrus peel [2-15-16], being an energy supplement to cover ruminant requirements [17]. Moreover, bioactive materials with antioxidant qualities like sugar, fiber, organic acids, phenolic compounds, and vitamin E can be found in citrus by-products (like pulp) [18-20].

After fresh oranges are pressed to obtain drink for human consumption, what's left over is called orange pulp (entire fruits without juice) [21-22]. Due to the significant amount of rapidly fermenting carbohydrates in DOP and various energy compounds for the ruminal microbiota, such as soluble carbohydrates and digestible neutral detergent fiber (NDF), DOP appears to be a high quality feedstuff and has a high nutritive value [2].

Prior research suggested that substituting DOP for grains in a dairy goat's diet did not lead to any negative effect on milk production, feed consumption, or digestibility [23-25]. Moreover, adding 40 and 80% levels of DOP to grains increased the quantity of vitamin E and phenols in lactating goat milk and enhanced the growth performance of the goat kids [26]. Breastfeeding cows given the DOP 75% substitution of YMG did not experience any negative health effects [16]. Lactating buffaloes fed a diet made up of a combination of DOP and dried tomato pomace (1:1) showed increased milk output [27]. In the same way, a study discovered that feeding lactation buffaloes a diet containing 20% of beet pulp and 10% DOP increased milk output and nutrient digestibility [28].

Research on the use of DOP and the advantageous effects of its bioactive components to alleviate the effect heat stress on lactating buffalo performance is still lacking. Thus, the aim of the current study was to investigate how partial replacement of YMG by DOP in the summer diet of Egyptian lactating buffalo affected the nutrients' digestibility, some blood parameters, milk production, composition, and economic efficiency.

Material and Methods

All fieldwork has been done at the Experimental and Agricultural Research Station (Buffalo Research Unit). Chemical analyses of feed ingredients, feces and blood measures were completed by Cairo University Research Park (CURP; Hormonal Laboratory) and the Department of Animal Production at the Faculty of Agriculture - Cairo University (Egypt). This study was accomplished during the summer months of July through September 2018. During this time, at the afternoon hours (between 13:00 and 14:00 h), it was noted that ambient temperatures ranged between 35 and 38°C and humidity levels between 54 and 55%.

Animals, experimental diets, and ethical clearance

For the experiment, 27 Egyptian buffaloes (600±50 kg; 1^{st} to 4^{th} parity) were used, and arbitrarily divided into 3 groups. The buffaloes were fed the experimental and control rations, in proper amounts, twice daily, at 7:00 and 19:00 h, to ensure that their nutritional demands were met. The lactating buffaloes were fed daily 8 kg of rice straw, 25 kg of Drawa, the green corn plants, and 8 kg of CFM, with a roughage concentrate ratio (R:C) of 65.60:34.40% for each. The average daily milk production per head at the beginning of the research was 6.43 kg ± 0.1 kg. The experimental animals were housed in open-air pens. Clean and fresh water was available freely throughout the day.

The CFMs consisted of yellow maize grains, soybean meal (44%), wheat bran, SDOP, sunflower meal (36%), and some additional feed additives. Three experimental rations were used, as Table 1 illustrates: R1, which consisted of 500 kg of YMG (Control); R2, which consisted of 350 kg of YMG plus 150 kg of SDOP (30% SDOP); and R3, which consisted of 200 kg of YMG plus 300 kg of SDOP (60% SDOP).

The current study was ethically approved and issued with number: CU/II/F/20/21 for the experimental design by Cairo University - the Institutional Animal Care and Use Committee (IACUC)- Giza, Egypt.

Digestibility trial and chemical composition of feeds and feces

Digestion studies were carried out in the last week of the experiment to ascertain the nutritional value and digestibility of the experimental ration. Each experimental animal's rectum was sampled three times in the morning and evening before feeding to obtain feces. In accordance with Van Kulen and Young [29], an internal marker, acid-insoluble ash (AIA), was utilized to assess the digestion coefficient of nutrients. The following nutrients, according to AOAC, were examined in fecal samples and experimental diets: dry matter (DM), crude protein (CP), organic matter (OM), ether extract (EE), and crude fiber (CF) [30]. The variation utilized in the nitrogen-free extract (NFE) formula. The following equations from Edwards and Allan [31] were used to determine total energy (GE; MJ/kg DM): [Carbohydrates (g) × 17.20] + [CP (g) × 23.60] + [EE (g) × 39.50]. TDN (nutritive values) was determined using the standard equation of McDonald et al. [32]. As per Van Kulen and Young [29], the estimate of nutrients digestibility was calculated as follows:

Total digestible nutrients (%) = [(Digestible EE (%) × 2.25) + Digestible CF (%) + Digestible NFE (%) + Digestible CP (%)].

Digestibility of DM (%) =100 – (100 x$\frac{Marker\% \ in \ feed}{Marker\% \ in \ feces}$).

- Digestibility of nutrients (%) = 100 – (100 x $\frac{\% \ nutrient \ in \ feces \times Marker\% \ of \ feed}{\% \ nutrient \ in \ feed \times Marker\% \ of \ feces}$).

Blood biochemistry

On day 90 of the trial 10-ml blood sample was taken from each animal's jugular vein. Samples were collected and placed in heparinized tubes. Then, the blood plasma blood was separated by centrifuging (4000 rpm - 15 min). Afterwards, blood samples were stored at -20 °C until analyzed.

Alanine transaminase (ALT) and aspartate transaminase (AST) activity (RFU/ml) was assayed using the Reitman and Frankel [33] method. The methods supplied by Cannon [34] and Doumas et al. [35] were followed for measuring total protein and albumin concentrations, respectively.

Total lipid, triglyceride, and cholesterol levels were measured following Eisemann et al. [36] methodology. A spectrophotometer (Jenway 6300; U.K.) was utilized to analyze all plasma parameters calorimetrically. The Stat lab szsl60 – Spectrum device was used to assess total antioxidant capacity, in accordance with Koracevic et al. [37] description. The levels of cortisol, immunoglobulin G (IgG), thyroxine (T4), and triiodothyronine (T3) were determined by ELISA (BIOTEK ELX808; USA).

Thermo-humidity index

Once a week, the humidity and ambient temperature (AT) were monitored during the hottest daytime (13:00 to 14:00 h). A dry bulb thermometer was used to measure the ambient temperature, and the wet and dry bulb thermometers were used to calculate RH. As a severity gauge of the HS in animals, a study by Mader et al. [38], concluded the temperature humidity index (THI) was determined using the following formula:

THI= 46.4 + [($\frac{RH}{100}$) + (AT; °C -14.4)] + (0.8×AT; °C).

Milk production, composition, and sampling

Manually, the buffalos were milked 2 times a day considering the first 3 weeks of the trial as an adaptation period, and milk yield was monitored every day until the experiment's finished. On the last 2 days of the experiments, representative and random samples of milk were taken and conserved under -20 °C until analyzed. A milko scan (type 10900 FOSS electric; 130 series; Denmark) was used to analyze the total solid -TS- content, fat, solid-not-fat (SNF), protein and lactose. Meanwhile, daily milk production (actual) was corrected into 4% FCM following Gaines [39] formula: [(fat yield, kg) ×15] + 0.4 × (milk production, kg).

Statistical analysis

All results were subjected to one-way ANOVA by SPSS software (V.15), using the statistical model:

$$Y_{ij} = \mu + T_i + E_{ij},$$

where: Y_{ij} = the dependent variable; μ = Over all mean; T_i = Treatment effect; E_{ij} = residual error. The mean ± SEM was used to express the results. After performing Tukey's multiple comparisons, the variations between groups were considered significant at $P < 0.05$.

Results and Discussion

In the current investigation, animals in R2 and R3 groups were fed CFMs that partially replaced YMG with 30% and 60% of SDOP, respectively, while animals in control (R1) got CFM without SDOP. Together with their prices, Table 1 displays the experimental CFMs' formula

When it came to feed costs, the price of CFM decreased as replacement levels of SDOP increased. This was because, during the trial period in July to September 2018, the average cost of 1 kg of YMG was 4.15 LE, but 2.20 LE per kg of SDOP. As a result, compared to Control, the CFM cost for 1 kg was lower in 30%SDOP and 60%SDOP by 0.293 and 0.585 LE, respectively (that is, it was lower by 6.6 and 13.17%, respectively, compared to control). This is the first indication that the work can be applied in buffalo feed manufacturers and farms of ruminant production to reduce the CFM cost and enhance profits.

Our findings were in accordance with those of Kemmere *et al*. [40], who fed dairy cows about 50% of the standard herd grain-based ration and 50% dried grapefruit meal . About 17.2% less was spent on a ton of rations because of this partial replacement. Additionally, Allam *et al*. [16] found that raising the replacement levels of YMG by DOP substitution level in dairy cow diets up to roughly 17% reduced the cost of CFM.

Composition of chemicals in the feed ingredients and CFMs used in the experiment

Chemical composition of feedstuffs and CFMs is reported in Table 2. Results showed that the CP and EE contents of SDOP and YMG were nearly identical. If not, SDOP's OM, DM, and NFE values were lower than YMG's. Nonetheless, SDOP's ash and CF values were greater than YMG's.

The contents of OM and CP in SDOP were determined to be 91–92 for OM and 7.2% for CP, which were almost identical to those reported by several studies [16 - 17]. Value of Ether extract in SDOP (4.77%) was quite similar to the values reported by Allam et al. [41]: 4.5% and the NRC [42]: 4.9%. Table 2 indicates that the CFMs were roughly isonitrogenous and isocaloric, with CP levels being roughly equal (17.33 to 17.60%).

Digestibility of nutrients and other nutritive values

Table 3 shows the results of digestion coefficients, the nutritive value expressed in digestible crude protein, and TDN for rations of the experiment containing different levels of SDOP substitution (30% and 60% of YMG) compared to the control diet. No statistically significant difference in the experimental digestibility of DM, OM, EE, and NFE when substituting SDOP for YMG is found (P>0.05). These results were consistent with those of other studies [43], [44], [45], who examined the effects of substituting dried citrus pulp (DCP) for barley grains at varying levels in the diets of goats, sheep, and fattening male calves, and found no discernible variation in the DM digestibility. Additionally, DCP was used in place of YMG in small ruminant rations by Allam et al. [41] and Gilaverte et al. [46], who concluded no significant difference in the overall digestibility of nutrients. Additionally, Shdaifat et al. [47] found no significant variations in the DM and OM digestion coefficients after substituting 20% of the barley grains in the dairy ewes' diet with DCP.

Comparison with control revealed a substantial decrease in CP digestibility concurrent with the SDOP substitution level ($P < 0.05$). However, Allam et al. [16] and Ben-Ghedalia et al. [45] observed that CP digestibility increased as the amount of DOP in ruminant diets increased. This might be explained by DOP that could improve N flow into the intestine by creating favorable ruminal conditions.

When the SDOP substitution level was increased in 30%SDOP and 60%SDOP relative to Control, a significant improvement in digestibility of CF was observed ($P < 0.05$). Grigelmo-Miguel and Martñn-Belloso [48] suggested that the reduced lignin content in DOP was linked to the improvement in CF digestibility. Furthermore, even at high dietary inclusion, it might also be connected to the DOP's capacity to promote ruminal fibrolytic bacteria-friendly environments [45], thereby, enhancing CF digestion. Allam et al. [16] concurred with these results.

In contrast to control and 30%SDOP, 60%SDOP recorded the lowest value for NFE digestibility (76.91 *vs* 69.3%). However, differences were not significant ($P > 0.05$). Maybe it due to the high variability.

Furthermore, TDN in the control group was numerically higher than 30%SDOP and 60%SDOP, with no significant differences found ($P > 0.05$). Additionally, because of decreasing CP digestibility, digestible CP was considerably reduced by raising the SDOP substitution amount ($P < 0.05$).

Effects on blood parameters

The blood biochemical indicators for the experimental animals are illustrated in Figure 1 and 2, and all of the parameters were confirmed to be within the normal ranges for adult buffalo.

Regarding blood parameters examined no discernible change was showed between groups. Comparable levels of total protein, albumin, hemoglobin, and liver enzyme activity (ALT and AST) were seen overall the experimental groups. Figure 1 indicate that total lipid, triglyceride, and cholesterol values did not differ significantly from the control. In the same context, Figure 2 showed no significant variation was seen for cortisol, T3, and T4 hormone levels. Additionally, the TAC values for control, 30%SDOP, and 60%SDOP were very similar 2.11, 2.05, and 2.09 mmol/L, respectively without reporting any significance ($P > 0.05$). The concentration of IgG was somewhat higher in R2 and R3 (9.97 and 9.90 mg/mL, respectively) when compared to control (9.54 mg/mL).

These results were consistent with those of Belibasakis and Tsirgogianni [49], who found that the blood total protein and albumin of dairy cows were not affected in a significant manner by the addition of dried beet pulp and ground maize to their diet when DCP replaced 20% of CFM. Further research on the effects of DOP replacement up to 50% of YMG in small ruminant rations on ALT, AST, and total protein levels was done by Allam et al. [41], who also showed that the blood parameters evaluated were within the normal range and that there was no significant variation between groups. Furthermore, Allam et al. [16] found that all blood measures were also within normal ranges after examining the impact of substituting DOP for up to 75% of YMG in the diets of dairy cows. On the other hand, Oni et al. [50] investigated the effects on several blood markers of adding DCP to the goat ration at varying percentages (up to 75%) in place of the dried brewers grains. They found that, in comparison to the control group, total protein and hemoglobin significantly increased with increasing substitution levels.

Milk yield and composition

This trial had a 12-weeks duration, with the first three weeks serving as an adaptation period during which SDOP was introduced, and the remaining 9 weeks being the experimental phase. Because SDCP's seeds and peels contain limonin, which gives them a bitter taste, buffalo needed to adapt during this time [51]. In addition, it's important to gradually introduce citrus by-products into animal diets so that animals become used to their unique flavor and aroma [52]. Additionally, it might alter the ruminal microbiota, which is closely linked to dietary item variation and may therefore have an impact on the wellfare and productivity of animals. Figure 3 displays the actual DMY and FCM results for the 9-weeks experiment and lists the chemical composition of milk.

In terms of DMY, no significant differences were reported among the groups; however, the highest value (6.06 kg/h/d) was for R2. According to many previous studies [53-55], our results were in agreement with theirs. Additionally, as illustrated in Figure 3, milk production as a 4% FCM increased in 30% SDOP but remained the same in 60% SDOP and control.

As SDOP replacement levels in the diets of lactating buffalo increased, the content of protein, lactose, and total solid in the milk increased as well, although the significance level was not reached ($P > 0.05$; Figure 3). However, the R2 and R3 groups showed a non-significant drop in milk fat content; nevertheless, R2 had the lowest value. Similarly, between the treatments and the control group, there was no change in milk ash ($P > 0.05$). These results were in line with those of Lima et al. [53], Assis et al. [54], and Wing [55], who discovered no significant change in the fat content of cows fed rations containing varying amounts of DCP.

These findings were discussed in light of earlier research that found adding DCP to the diets of lactating cows notably influenced milk composition, particularly the amount of fat in it. Santos et al. [18] found that feeding diets with 3% soybean oil, 9,and 18% DCP significantly decreased total solid and milk fat contents. Furthermore, Shdaifat et al. [47] looked at replacing 20% of barley grains with DCP in small ruminant diets and discovered that the milk fat had the tendency to be higher comparing to the control group (7.42 vs. 6.21%; $P < 0.08$).

All experimental groups showed no significant differences in the milk protein. These findings were consistent with those of Belibasakis and Tsirgogianni [49], who demonstrated that 20% of CFM, dried beet pulp, and ground maize were replaced with DCP in dairy cows without affecting the contents of milk protein. Additionally, when Assis et al. [54] replaced maize grains in the rations of lactating cows at percentages of 33%, 67%, and 100% with DCP, there was no significant change in the milk protein.

Similarly, there was no significant variation in the lactose content across the experimental groups. These results corroborated those made by Wing [55], who determined that adding DCP to the diets of lactating cattle had no notable effects. Furthermore, DCP substitution of 20% of CFM in lactating cows was studied by Belibasakis and Tsirgogianni [49] and found no discernible effect on lactose content. Moreover, the influence of substituting up to 18% of DCP in the diet of dairy cows was examined by Santos et al. [18], and discovered no markable change in the lactose content of the milk. When Lima et al. [53] investigated DCP supplementation effect as an antioxidant in canulated lactation cows, they found the same results.

In our study, the TS content of milk was found to be unaffected by the treatments ($P > 0.05$; Figure 3). Similar to these results, Belibasakis and Tsirgogianni [49] discovered that milk TS was not significantly impacted substituting 20% of CFM by DCP in lactating cows. Additionally, Assis et al. [54] revealed no notable changes in milk TS when they fed dairy cow diets that included DCP (33–100%) in place of maize grains.

Efficiency of feed and economics

Table 4 shows the effects on feed and economic efficiencies of partially substituting SDOP for YMG in the diets of lactating buffalo. Regarding the feed intake, raising the SDOP substation level resulted in a decrease in the overall dry matter intake. In comparison to control, this decline was account for by 0.63 and 0.83 kg/h/d, in the 30%SDOP and 60%SDOP, respectively. This was represented by a reduction in daily feed cost as well as the CFM price.

As the SDOP level rose, feed efficiency improved and control, 30%SDOP, and 60%SDOP representing 0.24, 0.29, and 0.25, respectively. Raising the DOP replacement levels in rations significantly not only reduced the cost of CFM but also total feed cost for producing 1 kg of milk. Thus, as the DOP replacement levels increased, so did the income (LE) and relative economic efficiency (REE).

In other words, elevating the YMG replacement level by SDOP, lowered the cost of daily feed (LE/head/day) to be 46.22, 42.58, and 39.9 for the control, 30%SDOP, and 60%SDOP, respectively. In addition, compared to the control group, the cost of feed (LE) per kg of milk decreased by 1.80 and 1.09 LE, or 20.4% and 12.36%, in 30%SDOP, and 60%SDOP, respectively. Additionally, prior gains resulted in an increase in REE for producing 1 kg of milk 30%SDOP, and 60%SDOP registering 2.11 and 1.48 times, respectively, over control.

These results were consistent with those obtained by Miron et al. [56], who found that feeding high-producing dairy cows feeds partially substituted with DCP (10–20%), instead of maize grains, increased the efficiency of feed. Additionally, Allam et al. [16] reported that the REE (%) of replacing YMG by DOP in the rations of lactating cows were 116.43, 120.65, and 126.08% at 25, 50, and 75% of replacing levels, respectively.

Environmental physical aspects

Figure 4 displays the THI, relative humidity, and ambient temperature that were noted throughout the summertime experimental period. The degree of heat stress was measured using the scale: Normal THI is 75 or less; alert is 75–78; danger is 79–83; emergency is 84 or more [57]. The buffaloes in the current study had a mean THI value of 89.9, which indicated that they were in the emergency category and indicated a stressed condition based on the prior index.

Once THI ranged between 72-89, buffalo's milk production, lipid content, and protein levels decreased [9–57]. The cortisol level in buffalo increased during heat stress, as stated by Kumar et al. [7] and Comin et al. [58]. Consequently, the cortisol result in the current study followed the same trend. Additionally, T3 concentration in buffalo was dramatically declining as the THI index rose [59].

According to our research, giving lactating buffaloes diets containing SDOP may prevent the summertime decline in milk yield and composition. Additionally, feeding SDOP did not lead hormones to become stressed out in response to heat stress; this could be clarified by the fact that DOP has a higher concentration of several bioactive anti-heat stressed chemicals than YMG, such as vitamin C.

Conclusion

According to the conditions of our study, it is possible to conclude that adding SDOP instead of YMG to the rations of lactating buffaloes improved the digestibility of CF while decreasing the digestibility of CP and its nutritional value as a digestible CP. Despite the fact that this experiment was conducted in the summer, none of the blood parameters in 30%SDOP or 60%SDOP were impacted by the substitution. Furthermore, there was no significant variation in the amount or composition of milk produced, meanwhile, feed efficiency and profitability were enhanced by SDOP inclusion into the diet. Moreover, Egyptian buffalo are well-suited to summertime living. Finally, the study found that farm profitability increased when SDOP was substituted for up to 60% of the YMG. This feeding strategy of reducing feeding costs without compromising animal performance or health is commercially viable among producers of ruminant feed and animal production farms

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Conflicts of interest

Authors declare that there were no conflicts of interest.

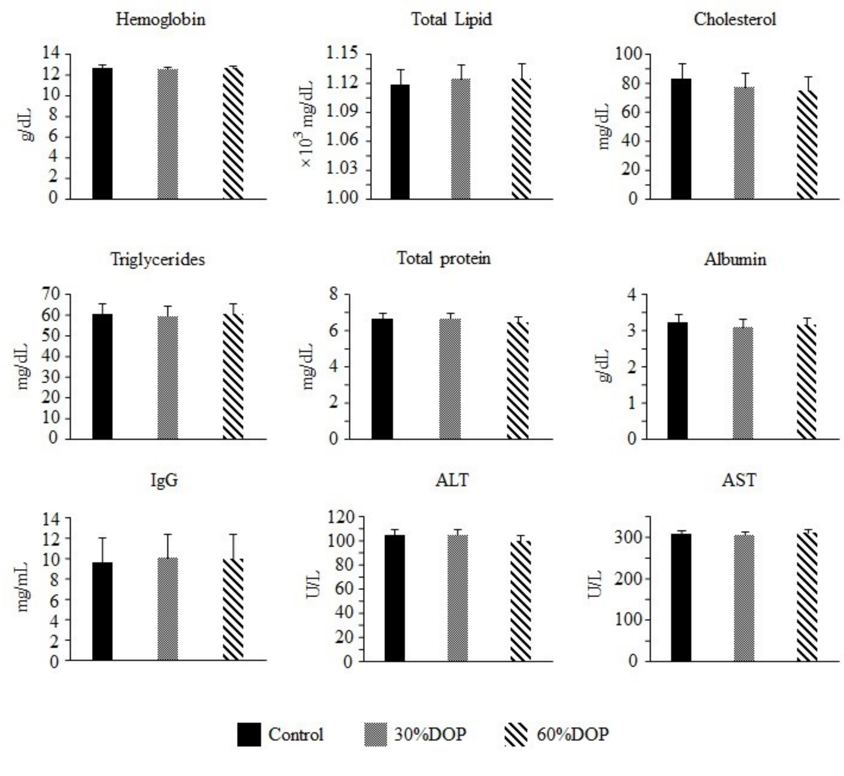

Fig. 1. Some blood indicators measured for the experimental buffaloes given SDOP at levels of 0, 30 and 60% as a partial substitute of YMG. Error bars refer to standard error of means. Symbols a, b, c (if given) indicate difference at P < 0.05. Control: SDOP-free CFM; 30%SDOP: A 30% partial replacement of YMG in the CMF; 60%SDOP: A 60% partial replacement of YMG in the CFM. IgG: immunoglobulin G; ALT: Alanine transaminase; AST: Aspartate transaminase.

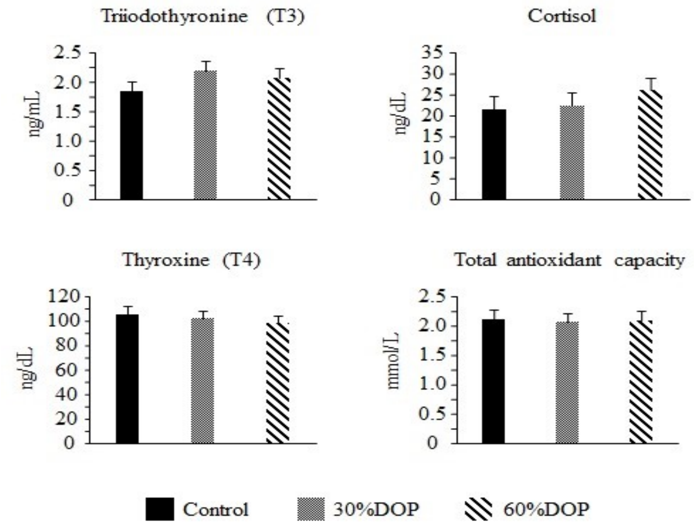

Fig. 2. Some hormonal indicators (triiodothyronine, thyroxine and cortisol) and total antioxidant capacity measured for the experimental buffaloes given SDOP at levels of 0, 30 and 60% as a partial substitute of YMG. Error bars refer to standard error of means. Symbols a, b, c (if given) indicate difference at *P* < 0.05. Control: SDOP-free CFM; 30%SDOP: A 30% partial replacement of YMG in the CMF; 60%SDOP: A 60% partial replacement of YMG in the CFM.

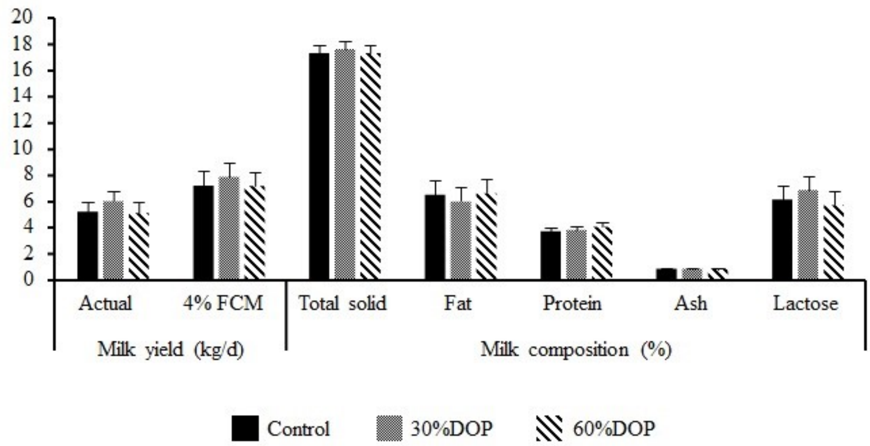

Fig. 3. Milk yield and composition for the experiment buffaloes given SDOP at levels of 0, 30 and 60% as a partial substitute of YMG. Error bars refer to standard error of means. Symbols a, b, c (if given) indicate difference at *P* < 0.05. Control: SDOP-free CFM; 30%SDOP: A 30% partial replacement of YMG in the CMF; 60%SDOP: A 60% partial replacement of YMG in the CFM. FCM: fat corrected milk.

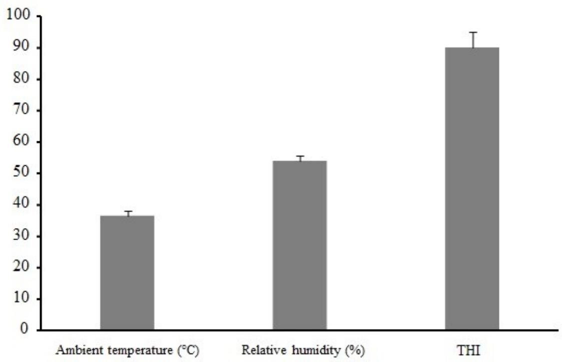

Fig. 4. Environmental aspects recorded during the experimental period. Error bars refer to standard error of means

TABLE 1. Formulation (g/kg) and price (LE/kg) of the experimental concentrate feed mixtures

Items	Feed mixtures concentrate		
	Control (R1)	30%SDOP (R2)	60%SDOP (R3)
Feed ingredients, g/kg			
Sun-Dried orange pulp	0	150	300
Yellow maize grains	500	350	200
Bran of wheat	200	200	200
Sunflower meal (36%)	100	100	100
Soybean meal (44%)	150	150	150
Sodium chloride	10	10	10
Limestone	21	21	21
Sodium bicarbonate	10	10	10
Dicalcium phosphate	4	4	4
Vitamins and minerals premix[1]	3	3	3
Yeast	1	1	1
Mycotoxins binder	1	1	1
Price (LE/kg)[2]	4.440	4.148	3.855

[1] Vitamins and minerals premix was formulated to fit lactating cattle requirements and produced by Dakahlia Company, May 2018 Sadat City, Egypt). [2] The average price (LE/kg) market of feed ingredients from July to September (2018) were: YMG (4150) and SDOP (2200). Control: SDOP-free CFM; 30%SDOP: A 30% partial replacement of YMG in the CMF; 60%SDOP: A 60% partial replacement of YMG in the CFM.

TABLE 2. Chemicals composition of the concentrate feeds mixtures and experimental rations (g/kg, except for GE) [1]

Items	Chemical composition (g/kg)							
	DM	OM	Ash	CF	CP	EE	NFE	GE
Feed ingredients								
Sun-Dried orange pulp	846.1	916.8	74.8	123.2	74.3	47.7	680.3	17.70
Yellow maize grains	906.3	986.9	13.1	25.5	80.1	42.7	838.6	18.70
Wheat bran	903.5	946.6	53.4	103.0	131.1	29.7	682.8	18.02
Sunflower meal	827.2	928.6	71.4	241.6	350.7	9.2	327.1	18.59
Soybean meal	917.5	936.2	63.8	41.7	439.2	15.1	440.2	19.39
Experimental CFMs								
Control	909.7	964.3	35.7	67.1	176.0	32.1	689.1	18.66
30% SDOP	901.9	955.4	44.6	82.4	174.7	32.1	666.2	18.49
60% SDOP	894.2	946.5	53.5	97.6	173.3	32.2	643.4	18.33

[1] Dry matter (DM), organic matter (OM), crude fiber (CF), crude protein (CP), ether extract (EE), nitrogen-free extract (NFE), gross energy (GE; MJ/kg DM; calculated). The CFM without SDOP was the control; 30% SDOP was the partial replacement of YMG in the CFM; 60% SDOP was the partial replacement of YMG in the CFM.

TABLE 3. The nutritive value as TDN and digestible CP, as well as the digestion coefficients of nutrients for the experimental rations (Control, 30%SDOP, and 60%SDOP)[1]

Items	Treatments			SEM
	Control (R1l	30%SDOP (R2)	60%SDOP (R3)	
Nutrients digestibility (%)				
DM	60.51a	61.18a	61.38a	0.507
OM	66.70a	68.87a	66.96a	0.358
CF	52.32a	56.47b	57.88c	0.509
CP	68.65a	64.87b	63.15c	0.347
EE	71.30a	70.75a	70.46a	0.310
NFE	76.91a	76.91a	69.30a	6.308
Nutritive values (%)				
Digestible CP	12.08a	11.33b	10.94c	0.06
TDN	73.71a	72.33a	66.28a	4.26

[1] Dry matter (DM), organic matter (OM), crude fiber (CF), crude protein (CP), ether extract (EE), nitrogen-free extract (NFE), and total digestible nutrients (TDN). Different symbols a, b, and c in the same row indicate differ at $P < 0.05$. The CFM without SDOP was the control; 30% SDOP was the partial replacement of YMG in the CFM; 60% SDOP was the partial replacement of YMG in the CFM.

TABLE 4. Feeding and milk yield efficiency and profitability for the experimental animals fed SDOP-containing diets at 0, 30 and 60% replacement of YMG.

Items	Treatments		
	Control (R1)	30%SDOP (R2)	60%SDOP (R3)
Milk production (kg/head/day)	5.24	6.06	5.16
Daily DMI (kg/head)	21.43	20.80	20.60
FE	0.24	0.29	0.25
Cost of feed (LE/ head/d)	46.22	42.58	39.9
Cost of feed per kg milk (LE)	8.82	7.02	7.73
Total income of milk production (LE/day)	57.65	66.64	56.78
Feeding net revenue (LE)	11.43	24.06	16.88
Economic feed efficiency %	24.7%	56.5%	42.3%
REE	1.00	2.11	1.48

Dry matter intake (DMI); Feed efficiency (FE) = milk produced (kg) / dry matter consumed (kg). Cost of feed (LE/h/d) = price of 1 kg CFM*8 + 8 kg rice straw * 0.4 LE + 25 kg Drawa*0.3 LE. Production feed cost (LE/ kg milk) = Daily feed cost (LE/h/d) / Average DMY (kg/h). Total income of milk production (LE/buffalo): Average DMY (kg/buffalo) * market price for 1 kg of buffalo milk (11 LE in September 2018). Feeding net revenue (LE) = Total income of milk production (LE) - Daily feed cost (LE). Relative economic efficiency (REE) = feeding net revenue (LE) per buffalo in each group relative to the control group.

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أثر الاستبدال الجزئي لحبوب الذرة الصفراء بتفل البرتقال الجاف علي أداء الجاموس الحلاب خلال فصل الصيف

محمد حسن بكر[1] ، صباح علام [1] ، ايمان سبعاوى [2] ، ابتهال العدوي[1] و فاطمة ابو هاشم [1]

[1] كلية الزراعة- جامعة القاهرة - مصر.

[2] المركز القومى للبحوث - مصر.

الملخص

فى هذه الدارسة تم تقسيم سبعة وعشرون من الجاموس المصري الحلاب (متوسط وزن الجسم 600 ± 50 كجم، في الموسم الأول إلى الرابع من الحليب) عشوائيًا إلى ثلاث مجموعات مماثلة لدراسة الاستبدال الجزئي لحبوب الذرة الصفراء بتفل البرتقال المجفف خلال موسم الصيف. تم دراسة استهلاك العلف، هضم العناصر الغذائية، إنتاج اللبن وتركيبه، بعض مؤشرات الدم والكفاءة الاقتصادية. وتم استبدال حبوب الذرة الصفراء بتفل البرتقال عند مستويات 0 و30 و60% في R1 (المقارنة) و R2و R3على التوالي. لوحظ انخفاض في إستهلاك المادة الجافة بمقدار 0.63 و0.83 كجم في R2 وR3، على التوالي، مقارنة مجموعة المقارنة. لم تتأثرمعاملات هضم المادة الجافة، المادة العضوية، الدهن الخام المستخلص الخالي من الآزت. وبالمثل، لم تتأثر قيمة المركبات الكلية المهضومة (TDN) بالمعاملة ($P > 0.05$). بخلاف ذلك، انخفض معامل هضم البروتين وكذلك البروتين المهضوم بشكل ملحوظ عن طريق زيادة مستوى استبدال تفل البرتقال المجفف. وعلى العكس من ذلك، أزداد معامل هضم الألياف الخام في R2 وR3 مقارنة بـ ($P < 0.05$) R1. لم يكن هناك اختلاف كبير في مؤشرات الدم (مستويات الهيموجلوبين، البروتين الكلي، الألبومين، ALT وAST، الدهون الكلية، الكولسترول، الدهون الثلاثية، T3، T4، الكورتيزول، إجمالي القدرة المضادة للأكسدة (TAC) وIgG؛ $P > 0.05$). أيضًا، لم يتم العثور على فروق ذات دلالة إحصائية بين المجموعات التجريبية ، لا في متوسط إنتاج اللبن اليومي ولا في اللبن معدل محتوى الدهون (FCM). وكذلك لم تصل الفروق في محتوى اللبن من بروتين والدهن واللاكتوز والمواد الصلبة الكلية والرماد إلى مستوى معنوي بين المجموعات التجريبية($P > 0.05$) . علاوة على ذلك، انخفضت تكلفة مخلوط العلف المركز (جنيه/طن) بنسبة 6.6% و13.2% في R2 وR3 على التوالي، مقارنة بـ R1 مما يؤثر إيجاباً على تكاليف التغذية لإنتاج 1 كجم حليب.

الكلمات الدالة: تغذية الجاموس ، تفل البرتقال المجفف، الإجهاد الحراري، الكفاءة الغذائية ، الكفاءة الاقتصادية.