MILK PRODUCTION AND SOME BLOOD METABOLITE RESPONSES TO YEAST SUPPLEMENTATION IN EARLY LACTATING HOLSTEIN DAIRY COWS

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SUMMARY

The present study was undertaken to investigate the effect of supplementation of two commercial products, Tonilisat yeast (TY) and Grow yeast (GY) on milk production, milk composition and blood metabolites in lactating dairy cows. Eighteen early lactating Holstein dairy cows were divided into three groups of six cows per each group for three months. The supplement levels of TY and GY product were 3.75 and 15g/cow/d, respectively, which were mixed with the concentrate mixture. The results show that dry matter intake (DMI) was not ($P > 0.164$) affected by TY or GY supplementation compared to the control group. The inclusion of TY or GY increased ($P<0.05$) milk yield by 3.76 and 2.93 kg/d, respectively compared to the control group. The enhancement in milk yield was 15.5 and 12.1 % by TY and GY supplementation, respectively compared to the control group. Both types of yeast products supplementation to early lactating dairy cows improved ($P<0.05$) fat corrected milk (FCM), energy corrected milk (ECM) and feed efficiency compared to the control diet. Milk fat, milk protein and solids- not- fat (SNF) yields were increased ($P<0.05$) in the two yeast supplemental groups compared to the control animals. TY yeast products inclusion in the diet increased ($P<0.05$) the serum total protein and globulin concentrations compared to the GY product and control groups, while both products had no significant effect on albumin concentration compared to the control diet. Cholesterol concentration was increased ($P<0.05$) by adding GY to the diet of the dairy cows compared to the TY and control groups. From the present results it can be concluded that both TY and GY products have favorable impacts on the productivity of dairy cows during early lactation.

Keywords: Yeast supplementation, productive performance, blood metabolites, dairy cows

INTRODUCTION

Microbial additives such as *Saccharomyces cerevisiae* products have been widely used in ruminant nutrition to manipulate rumen fermentation and improve animal performance. Yeast culture or yeast products (YP) are widely utilized as feed ingredients or feed additives in animal nutrition. Yeast products may affect rumen fermentation and nutrient digestion, thus some authors (Erasmus *et al.*, 2005 and Abou-Elenin *et al.*, 2011) have indicated that feeding yeast products may be most beneficial to dairy cows during late gestation and early lactation when these effects of yeast cultures might be most valuable.

There is a widespread belief among dairy, beef and sheep producers that yeast supplementation is beneficial by enhancing dry matter intake (DMI) and animal performance (Moallem *et al.*, 2009 and Robinson and Erasmus, 2009) and at the same time prevent health disorders (Chaucheyras-Durand *et al.*, 2008). Furthermore, studies on dairy cows indicated that supplementation with yeast culture increased DMI and milk production, and improved milk composition (Stella *et al.*, 2007). Ruminal fermentation and animal performance have been manipulated with different feed additives, including microbial products and ionophores, to improve animal production (Wallace, 1994). However, Galip (2006) showed that the addition of yeast culture to the diet of rams has induced systemic biochemical changes: serum total protein, urea, calcium concentrations and Ca/creatinine ratio were increased, whereas triglyceride concentrations were lowered as a result of supplementation with YC in diet. In contrast, another study showed that supplementation of the lamb's rations with probiotics had a non significant effect on some blood constituents (Ismaiel *et al.*, 2010).

The studies with *Saccharomyces cerevisiae* had suggested variable and inconsistent results (Mir and Mir, 1994). The effect of active dry yeast supplementation vary depending on biotic factors such as the strain of yeast and its viability and on biotic factors such as the nature of the diet, animal type and it's management, the physiological status and the level of production. Therefore, the present study was conducted to determine the effects of dietary supplementation with two commercial yeast products on feed efficiency, blood metabolites and milk production and its composition of multiparous Holstein dairy cows at early lactation.

MATERIALS AND METHODS

This study was conducted at the milk production project and Department of Animal Production, Faculty of Agriculture, Alexandria University, Egypt.

Animals and management:

Eighteen lactating multiparous Holstein cows (500±12.34 kg BW) with similar milk production at early lactation were randomly assigned into three equal groups of 6 cows each. Animals were fed concentrate mixture and green clover (*Trifolum alexandrinum*) without (control) or with addition of Tonilisat yeast, TY (3.75 g/cow/d of TY powder) or Grow yeast, GY (15 g/cow/d of GY powder) according to the manufacture of each product. Cows were randomly assigned to the experimental groups after being sorted by parity and days in milk production. The daily amount of yeast was mixed for each treated group with the concentrate mixture at 06:00 h.

Cows were fed in stalls three times daily at 0600, 12:00 and 1800 h for a three months of lactation. The ration was balanced for minerals and vitamins and was formulated to meet the nutrient requirements of cows according to NRC (2001) recommendations (Table 1). Amounts of concentrate and roughage offered were recorded daily. Cows were milked automatically at 05:00, 11:00 and 17:00 h and milk yield was recorded and sampled weekly. Blood samples were collected biweekly using vacutainer tubes without coagulant from the tail vein of dairy cows prior to morning feeding. Blood samples were centrifuged for 20 min at 3000xg and sera were stored at -20^{o}C until biochemical analysis.

Table 1. Ingredients and chemical composition of the concentrate mixture and green clover

Ingredient (%)	Concentrate mixture	Green clover
Ground yellow corn	45.0	-
Wheat bran	25.0	-
Cotton seed meal	22.0	-
Soybean meal	10.0	-
Limestone	1.8	-
Sodium chloride	1.0	-
Trace minerals	0.3	-
Chemical composition (%) on DM basis		
Organic matter	89.5	90.5
Crude protein	18.1	15.2
Ether extract	3.7	1.6
Neutral detergent fiber (NDF)	44.1	55.1
Acid detergent fiber (ADF)	19.2	50.5

Sample analysis

Analytical DM content of the diet samples was determined by drying at 135°C for 3 h, and organic matter (OM) was determined as the weight loss on ashing at 550°C for 2 hr. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to the procedures of Van Soest *et al.* (1991). Milk samples were analyzed immediately by milk scan (Eko-milk of milk analyzer, Milkana KAM 98-2A, USA) based on infrared technology for fat, protein, density and solid not fat percentages, and were stored at -20^{o}C for total solids and ash analyses. Lactose concentration was calculated by difference [Lactose=TS-(milk protein+ milk fat+ash)]. Average fat and protein yields were calculated by multiplying milk yield by fat or protein percentages of milk on an individual cow basis. Energy corrected milk (ECM) was determined on an individual cow basis using the milk fat and protein yields according to Tyrrell and Reid (1965), and 4% fat corrected milk (FCM) was calculated according to Gaines and Davidson (1923).

Concentrations of serum total protein, albumin, glucose, urea, triglycerides, cholesterol and creatinine were determined using commercial colorimetric kits according to Armstrong and Carr (1964), Doumas *et al.* (1977), Folin and Wu (1920), Henry (1974), Jaffe (1886), respectively. The concentration of globulin in each serum sample was obtained by subtracting the value of albumin from the serum total protein concentration.

Statistical analysis

Statistical analysis was conducted using the general linear models procedure of SAS (2002), with methods of Steel and Torrie (1980) to determine differences due to yeast addition. The significance differences were tested at level (P<0.05).

RESULTS

Dry matter intake (DMI), milk yield, fat corrected milk (FCM), energy corrected milk (ECM), feed efficiency and milk composition of early lactating dairy cows without (control) or with TY or GY supplements are presented in Table (2). Results show that overall means of DMI were not affected by TY or GY inclusion in the diet compared to the control group. The supplementation of TY or GY increased significantly (P<0.05) milk yield compared to the control group by 3.76 and 2.93 kg/d, respectively. The increment percent in milk yield was 15.5 and 12.1 % by TY and GY supplementation, respectively. Both two types of yeast products, TY and GY, supplementation to early lactating dairy cows improved (P<0.05) FCM (26.4 and 25.7 vs. 23.6 kg/d), ECM (29.0 and 28.4 vs. 26.0 kg/d) and feed efficiency (1.49 and 1.43 *vs.* 1.29 kg milk/kg DMI), respectively compared to the control diet.

Results also indicate that the percentages and yield of milk composition varied between treated and untreated dairy cows. Fat and solids-not-fat (SNF) percentages were not significantly affected by addition of both yeast products, while TY supplemented group revealed lowered (P<0.05) milk protein percentage than the GY and control groups. In contrast, milk fat, milk protein and SNF yields were increased (P<0.05) in the two yeast-supplemented groups compared to the control animals. In addition, the results show that the milk yield, FCM, ECM, feed efficiency, fat, protein and SNF yields were higher, but not significant, in both TY and GY groups than control group. The effect of the two yeast products supplementation on milk yield profile in early lactation dairy cows throughout experimental weeks is shown in Figure (1).

Table 2. Effect of two types of yeast supplementation on the overall means of dry matter intake (DMI), feed efficiency (FE), milk yield and its composition in early lactating Holstein dairy cows

Traits	Control	Tonilisat yeast (TY)	Grow yeast (GY)
Average DMI, kg/d	18.77±0.78	18.72±1.04	19.01±1.19
Milk yield, kg/d	24.20±0.68[b]	27.96±0.65[a]	27.13±0.72[a]
ECM, kg/d	25.96±0.72[b]	29.0±0.69[a]	28.41±0.68[a]
FCM, kg/d	23.62±0.66[b]	26.44±0.63[a]	25.74±0.69[a]
Feed efficiency, kg milk/kg DMI	1.29±0.036[b]	1.49±0.035[a]	1.43±0.038[a]
Milk composition			
Fat, %	3.84±0.085	3.63±0.075	3.66±0.074
Fat yield, kg/d	0.93±0.023[b]	1.01±0.020[a]	0.99±0.020[a]
Protein, %	3.46±0.028[a]	3.33±0.027[b]	3.42±0.029[a]
Protein yield, kg/d	0.84±0.008[b]	0.93±0.007[a]	0.93±0.008[a]
Lactose, %	4.80±0.21	4.93±0.18	5.12±0.19
SNF, %	9.08±0.07	8.90±0.07	9.07±0.07
SNF yield, kg/d	2.20±0.018[b]	2.49±0.018[a]	2.46±0.019[a]
Total solids, %	14.87±0.58	13.49±0.42	13.90±0.44
Ash, %	0.83±0.04	0.77±0.03	0.81±0.03

[a,b] Different superscript letters within the same row indicate significant difference (P<0.05).
ECM: Energy corrected milk, FCM: Fat corrected milk and SNF: Solids- not- fat.

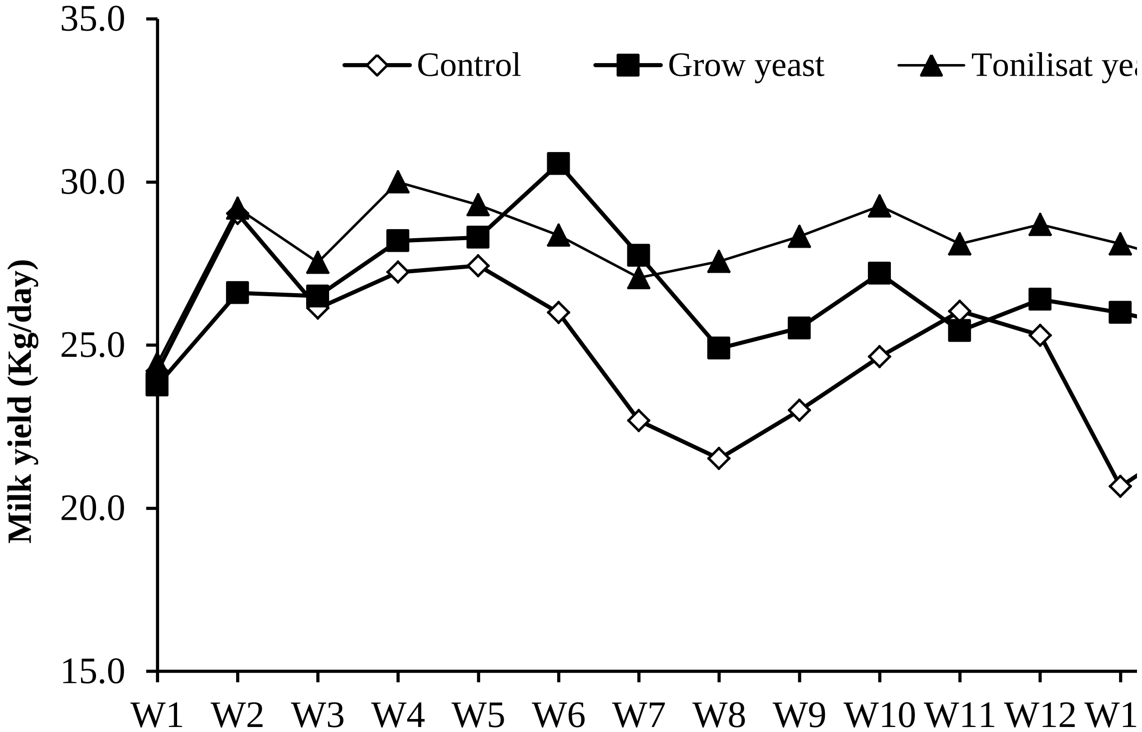

Figure 1. Effect of two types of yeast products supplementation on milk production profile (kg/day) in early lactating Holstein dairy cows

Data to evaluate the effect of two yeast products supplementation on blood metabolites in early lactating dairy cows is presented in Table 3. Results show that TY product inclusion in dairy cows' diet increased (P<0.05) serum concentrations of total protein and globulin compared to the GY product and control group, while both products had no significant effect on albumin concentration compared to the control group. Serum cholesterol concentration was increased (P<0.05) in cows supplemented with GY compared to the TY and control groups. Supplementation of the two yeast products had no significant effects on serum glucose, urea, triglycerides and creatinine concentrations compared to the control group.

Table 3. Effect of two types of yeast supplementation on blood metabolites in early lactating Holstein dairy cows

Parameters	Control	Tonilisat yeast (TY)	Grow yeast (GY)
Total protein, g/dL	8.06± 0.10[b]	8.57± 0.12[a]	7.83±0.10[b]
Albumin, g/dL	4.20±0.05[ab]	4.13±0.05[b]	4.31±0.05[a]
Globulin, g/dL	3.86±0.11[b]	4.44±0.13[a]	3.52±0.12[c]
Urea, mg/dL	15.26±0.48	15.61±0.55	15.89±0.50
Glucose, mg/dL	52.50±1.05	49.35±1.20	50.88±1.08
Cholesterol, mg/dL	161.30±5.81[b]	147.97±6.64[b]	185.52±5.98[a]
Creatinine, mg/dL	1.02±0.02	1.05±0.03	1.01±0.02
Triglycerides, mg/dL	10.86±1.12	11.06±1.27	10.91±1.15

[a,b-c] Different superscript letters within the same row indicate significant difference (P<0.05)

DISCUSSION

Dry matter intake and milk production

The present results are in agreement with previous reports by Schingoethe *et al.* (2004) and Bagheri *et al.* (2009). However, addition of cultures of *S. cerevisiae* to the diet of dairy cows had mixed effects on DM intake of dairy cows. When fed during the transition period, a culture of *S. cerevisiae* failed to increase DMI pre- and postpartum (Robinson and Garrett, 1999). Furthermore, feeding culture of *S. cerevisiae* at mid-lactation in dairy cows had no effect on DMI (Schingoethe *et al.*, 2004). However, some studies indicated increases in DMI and feed efficiency of ruminants fed yeast culture (Wohlt *et al.*, 1991 and Schingoethe *et al.*, 2004). Increased feed intake will lead to increased productive output of animals by providing more nutrients to the animal. This positive effect may result from manipulating rumen fermentation, stimulating cellulolytics in the rumen, improving fiber digestion, altering acetate to propionate ratios and increasing microbial protein flow to the duodenum (Bertin and Andrieu, 2005). The beneficial effects of yeast culture on fiber digestion may be partly responsible for the increase in DMI often observed with yeast feeding (Jouany, 2006).

Dairy cattle production is generally expressed in terms of daily milk production; energy corrected milk (ECM) or feed efficiency. The inclusion of yeast probiotics in feed benefits the cows with already developed rumen by increasing palatability, stimulating cellulolytic bacteria and thus the rumen fermentation, improving nutrient digestibility in the rumen, preventing a decline in rumen pH by decreasing lactic acid production and/or increasing utilization of lactic acid by some bacteria and hence improve productivity as noted in the current study (Schingoethe *et al.*, 2004; Bertin and Andrieu 2005 and Robinson and Erasmus, 2009). In addition, Bertin and Andrieu (2005) demonstrated the beneficial effect of Yea-Sacc on the performance of high-producing dairy cows and it significantly improved milk production. Moreover, Abo El-Nor and Kholif (1998) and Kholif *et al.* (2000) found that adding 10–15 g Yea-Sacc increased significantly milk production by about 20% in addition to improving digestion coefficient of different nutrients and milk quality. They emphasized that the positive effect of yeasts additives may be related to stimulation of growth of cellulolytic bacteria, which led to enhanced fiber digestibility and nutrients supply to the mammary gland rather than mobilization of body reserves. In addition, increased mammary secretion of protein might be due to increased synthesis of microbial protein and increased supply of metabolizable protein to the intestine of cows.

On the other hand, there are reports of negligible effect of yeast culture supplementation on both milk production (Schingoethe *et al.*, 2004; Bagheri *et al.*, 2009) and growth parameters (Mir and Mir, 1994). Dawson (2000), in a review of 22 trials with more than 9039 dairy cattle and 22 trials with beef cattle, reported an average increase of 7.3% (ranging between 2% and 30%) in milk production from dairy cattle, and 8.7% (ranging between 0% and 20%) mean increase in average daily gain of beef cattle.

The response of ruminant production to yeast supplementation is variable. In some cases, many of the commonly reported effects are observed and in others, little or no effect is observed. Researchers suggested that the response to yeast supplementation may depend on the composition of the diet, method of preparation of the yeast product and the conditions of the rumen and environment (Dawson, 1995). In addition, Wohlt *et al.* (1991) reported that variations in the response may be due to other parameters such as stage of lactation or the way the yeast is presented [e.g. in an *ad-lib* ration or once daily top dressed on the feed]. The response to supplementation with yeast culture may be more likely when animals are fed a poor quality diet or when rumen fermentation is disturbed (Dawson, 1995). Moreover, differences in response to added yeast may be due to interactions among yeast, diet and stage of lactation.

Milk composition

In contrast to that of milk production, percentages of milk composition in the current study were not affected significantly by yeast culture supplementation (Table, 2). While, fat, protein and SNF yields tended to be higher (P<0.05) in cows supplemented with TY or GY compared with those from cows fed the control diet. The enhancement of fat and protein yields were also observed by other researches (Wohlt *et al.*, 1991 and Moallem *et al.*, 2009) in response to yeast culture supplementation and was attributed to the increased milk production and increased fiber fermentation in the yeast fed-cows and this could potentially enhance milk fat production.

The present results illustrate that yeast supplementation did not affect milk fat percentage, possibly because of sufficient forage NDF in the diet to maintain effective rumen fermentation and milk fat synthesis. Also, increased production of milk protein and fat might indicate that changes in rumen fermentation as a result of feeding yeast culture increased the supply of glucogenic, aminogenic and lipogenic substrates (Erasmus *et al.*, 2005). Another explanation for increased synthesis of milk protein is a possible change in the profile of intestinally absorbed amino acids. When a culture of *S. cerevisiae* was fed to dairy cows, the duodenal flow of methionine increased from 41 to 58 g/d, which could favor synthesis of milk protein if methionine was a limiting amino acid in the diet (Schwab *et al.*, 1992). The increased synthesis of milk and SNF in milk in the current study suggests that the supply of nutrients for milk synthesis was altered as reported by Bruno *et al.* (2009).

In contrast, some studies have shown that yeast culture had no beneficial effect on milk composition of dairy cows (Bagheri *et al.*, 2009). Furthermore, Moallem *et al.* (2009) reported no differences in milk protein percentage and milk protein yield. The results of over 110 papers and 157 experiments showed that yeast supplementation increased milk yield without any significant effect on milk composition (Desnoyers *et al.*, 2009).

Blood metabolites

Blood metabolites are frequently used to monitor the metabolic health status of dairy herds. The present data showed that serum concentrations of glucose, triglycerides, albumin and creatinine were unaffected by the two yeast products supplementation, while TY products increased (P<0.05) the serum concentration of total protein and globulin compared to the GY product and the control group (Table 3). Also, cholesterol concentration was increased (P<0.05) by adding GY to the dairy cows compared to the control group. The results obtained by Bagheri *et al.* (2009) and Khormizi *et al.* (2010) indicated that glucose, cholesterol, urea, total protein and albumin of blood plasma were not affected by supplementation with yeast culture. Raghab *et al.* (2003) also recorded that dietary supplementation of yeast (Lact-Sac) resulted in significant decreases in the concentration of albumin (5.4%) and cholesterol (7.8%), but a significant increase in glucose (9.9%) was observed in blood serum of supplemented calves compared with their control. The increase in serum protein and albumin may be an indication of protein reserves in body as reported by Allison (1995). In addition, Abou-Elenin *et al.* (2011) investigated the effect of yeast culture (*Saccharomyces cerevisiae*) on some blood metabolites in lactating crossbred cows, which were fed a basal ration plus 10 g/h/d of the yeast culture. They found that the estimated values of the studied blood parameters were within the normal range. Concentrations of plasma total protein were not influenced by the experimental diet. In all groups, albumin concentrations were declined slightly by the advancement of time post feeding. After 6-h post feeding, differences in total protein was not significant among groups but differences between groups in concentrations of albumin, globulin, and creatinine were highly significant. Buch (1991) reported positive correlations between plasma total protein and albumin and the absorbed or synthesized protein. Albumin level is a reflection of liver function, its increase indicates higher ability of the animal to synthesize and store more protein (Ashour *et al.*, 2004). The differences between some previous studies and the results in present study may be due to the stage of lactation, feeding strategy, environmental conditions, diet composition, type of forage, type and dose of yeast product and type of yeast feeding.

CONCLUSIONS

Inclusion of TY or GY into the diet of early lactated dairy cow increased milk yield, fat corrected milk, energy corrected milk and feed efficiency. Moreover, milk fat, protein and solid- not- fat yields were increased in the two yeast- supplemented groups compared to the control animals. Thus, the results of the current study suggest that the two yeast products have favorable impacts on the productivity of dairy cows at early lactation.

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الإستجابات في انتاج اللبن وبعض المعايير الميتابوليزمية في الدم لإضافة الخميرة لأبقار الهوليشتين الحديثة الولادة

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أجريت هذه الدراسة لتقييم تأثير إضافة منتجين تجاريين للخمائر هما خميرة التونيليسات Tonilisat yeast (TY) وخميرة الجورو Grow yeast (GY) على إنتاج اللبن ومكوناته وعلى المقاييس البيوكيميائية للدم للأبقار الحلابة حديثة الولادة. وفي هذه الدراسة تم إستخدام ١٨ بقرة هوليشتين حلابة حيث قسمت إلى ثلاث مجاميع (٦ أبقار لكل مجموعة) لمدة ٣ شهور. وكانت مستويات الإضافة من خميرة التونيليسات وخميرة الجورو ٣.٧٥ و ١٥ جم/ بقرة/ يوم على الترتيب وكانت تضاف مع مخلوط العلف المركز يومياً. أوضحت نتائج الدراسة أن كمية المادة الجافة المأكولة لم تتأثر معنوياً بإضافة كلاً من المنتجين بالمقارنة بالمجموعة غير المعاملة. في حين أن إضافة خميرة التونيليسات وخميرة الجورو أدت إلى زيادة معنوية.(P<0.05) في محصول اللبن بمقدار ٣.٧٦ و ٢.٩٣ كجم/ يوم على الترتيب بالمقارنة بالمجموعة الكنترول. وكانت نسبة الزيادة في محصول اللبن ١٥.٥ و ١٢.١% باستخدام خميرة التونيليسات وخميرة الجورو على الترتيب بالمقارنة بالمجموعة الضابطة . كلاً من المنتجين أدت إلى زيادة كمية اللبن المعدل على أساس ٤% دهن وكمية اللبن المعدلة على أساس الطاقة والكفاءة الغذائية بالمقارنة بالمجموعة الكنترول. محصول دهن اللبن والبروتين والمواد الصلبة غير الدهنية حدث لها زيادة معنوية (P<0.05) في كلتا المجموعتين المعاملتين بالمقارنة بالمجموعة الكنترول. خميرة التونيليسات أدت إلى زيادة معنوية في تركيز البروتين الكلى و الجلوبيولين بالسيرم بالمقارنة بالمجموعة المعاملة بخميرة الجورو وكذلك بالمجموعة الكنترول. بينما كلا المنتجين لم يكن له تأثير معنوي على تركيز الألبيومين بالمقارنة بالمجموعة الكنترول. بينما تركيز الكوليسترول حدث له زيادة معنوية (P<0.05) بإضافة خميرة الجورو للأبقار الحلابة بالمقارنة بالمجموعة المعاملة بخميرة بالتونيلسات أو بالمجموعة الكنترول. من هنا نستنتج أن كل من خميرة التونيلسات وخميرة الجورو لهما تأثيرات إيجابية على إنتاجية أبقار الهوليشتين الحلابة فى بداية موسم الحليب.