# Effect of Supplemental Dry Yeast Culture *(Saccharomyces cerevisiae)* on Performance, Diet Digestibility and Rumen Fermentation Parameters in Growing Camels

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# تأثير إضافة الخميرة الجافة على كفاءة الآداء و معاملات هضم العليقة و تخمرات الكرش في الجمال النامية

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في هذه التجربة تمت إضافة مستويات مختلفة من الخميرة الجافة إلى علائق ذكور الجمال النامية في عدد أربعة مراحل غذائية متتالية و ذلك لدراسة أثرها على أداء الحيوانات ومعدلات هضم المواد الغذائية و تخمرات الكرش بالإضافة إلى بعض التغيرات البيوكيمائية في الدم. وقد استغرقت كل مرحلة مدة ٤٢ يوم (اعتبرت الخمسة أيام الأخيرة من كل مرحلة فترة تجميعية). تم استخدام عدد ٤ من ذكور الجمال النامية وحيدة السام متوسط أعمارها ١٦ شهراً و أوزانها ٢٣٥ كجم. غذيت الحيوانات كمجموعة واحدة خلال المراحل الغذائية الأربعة على العليقة الأساسية المحتوية على الاحتياجات الضرورية و الموصى بها لهذا النوع من الحيوانات في هذه المرحلة من العمر ( ٢,٢٣ ميجا كالوري/ كجم عليقه من الطاقة الممثلة و ١٢,٣ % بروتين خام). في المرحلة الأولى التي اعتبرت ضابطة غذيت الجمال على العليقة الأساسية بدون إضافة الخميرة بينما في المراحل الغذائية الثانية و الثالثة و الرابعة أضيفت الخميرة الجافة إلى العليقة الأساسية بنسب٢ ، ٤ ، ٦ جم خميرة جافة/كجم عليقه بالترتيب. تم تسجيل كمية العليقة اليومية المقدمة للحيوان و الكمية المتبقية وذلك لحساب كمية العلف المستهلك في اليوم وتم حساب معدل الزيادة اليومي في وزن الجسم وكذلك حساب معدل النمو النسبي وكفاءة التحويل الغذائي و ذلك لمعرفة كفاءة الأداء للحيوانات. تم تجميع الفضلات المخرجة يوميا و تحليلها خلال فترة التجميع لكل مرحلة لقياس معدلات هضم المواد الغذائية. تم جمع عينات سائل الكرش خلال اليومين الأخيرين من فترة التجميع بعد ٣ و ٦ ساعات من تناول عليقه الصباح لدراسة تخمرات الكرش وكذلك تم تجميع عينات دم من الحيوانات في نهاية كل مرحلة

غذائية لقياس بعض التغيرات البيوكيمائية في الدم. أشارت النتائج الى زيادة معدل استهلاك الطعام في الجمال المغذاة على عليقه مضافا إليها ٤ ، ٦ جم خميرة/كجم عليقه في المرحلتين الثالثة و الرابعة (٢,٦٨ & ٢,٥٧ كجم عليقه/١٠٠كجم من وزن الحيوان الحي) بالمقارنة بالعليقة الضابطة (٢,٤٧ كجم عليقه/١٠٠كجم من وزن الحيوان الحي). كان معدل الزيادة في وزن الجسم أعلى في المراحل الغذائية الثانية و الثالثة و الرابعة (٧٥٧ ، ١٠٠٦ ، ٩٩٠ جم/يوم) مقارنة بالمرحلة الضابطة (٦٥٧جم/يوم). كما أدت التغذية على الخميرة الجافة الى تحسن معدل النمو النسبي وكفاءة التحويل الغذائي خاصة في المرحلة الثالثة و التي احتوت العليقة بها على ٤ جم خميرة جافة /كجم عليقه. تحسنت معنويا معاملات الهضم الظاهرية لكل من المادة الجافة بمقدار ٥,٩ ، ٧,٧ ، ١١ ، ٧,٥ % و البروتين الخام بمقدار ٣,٥ ، ١٠,٦ ، ٧,٣ % و الألياف الخام بمقدار ٧,٧ ، ١٤,١ ، ١٢,٣ % في المراحل الغذائية الثانية و الثالثة و الرابعة بالترتيب عنها في المرحلة الأولى الضابطة مما أدى إلى ارتفاع القيمة الغذائية للعليقة مقدرة في صورة مجموع المواد الغذائية المهضومة او البروتين الخام المهضوم. بالنسبة لتخمرات الكرش, أدت التغذية على الخميرة الجافة إلى زيادة طفيفة في درجة حموضة الكرش و تركيز كل من الامونيا و الأحماض الدهنية الطيارة التي تدل على ارتفاع نشاط الكائنات الحية الدقيقة بالكرش. عدم وجود أي فارق معنوي في تركيز كل من البروتين الكلي والألبومين والجلوبيولين و الجليكوز والكولسترول و اليوريا في مصل دم الجمال في المراحل الغذائية المختلفة. نستخلص من هذه الدراسة ان إضافة الخميرة الجافة (٤جم/كجم عليقه) إلى علائق ذكور الجمال النامية لها تأثير إيجابي على معدل استهلاك العليقة و كفاءة الأداء بالإضافة إلى تحسن معاملات هضم المواد الغذائية و تخمرات الكرش.

## SUMMARY

In this experiment, four serial feeding stages were conducted on male growing dromedary camels to study the effect of adding different levels of dry yeast *(Saccharomyces cerevisiae)* on growth performance, nutrient digestibility and rumen fermentation, in addition to some blood biochemical parameters. Each feeding stage extended for about 42 days and the last 5 days in each stage were assigned for fecal collection. Four one hump bull camel calves; of about 16 months in age and 235 kg average body weight were used in this experiment. The four animals (forming one group) were fed during four-stage periods on basal ration containing the recommended requirements for energy (2.23 Mcal ME/kg diet and protein (12.3 %) and supplemented with different levels of dry yeast culture. Camels in the first feeding stage fed on yeast free basal

ration and considered as control with which the digestibility and performance of the other stages were compared. In the second, third, and fourth stages, dry yeast was added at the rate of 2, 4, and 6 g /kg diet respectively to the basal ration. Feed offering and orts were recorded daily for determination of feed intake. The growth performance including body weight gain (BWG), relative growth rate (RGR) and feed efficiency was calculated in different feeding stages. Collected fecal samples were dried and analyzed for nutrient digestibility estimation using ash-less method. Rumen liquor was obtained by esophageal stomach tube at 3 & 6 hours after morning meal on the last 2 days of each experimental-stage periods for rumen fermentation parameters estimation. Blood samples were taken from animals in the morning before feeding at the end of each stage, sera separated and analyzed for determination of some blood biochemical parameters. The results showed that, camels supplemented with 4 &6 g yeast/kg diet in the third and fourth feeding stages consumed higher amounts of feed (2.68 & 2.57 kg DM/100kg LBW) compared with control (2.47 kg DM/100kg LBW). Unsupplemented camel calves had lower average daily gain (657g/day) than those with 2, 4, and 6 g/kg diet yeast supplement (757, 1006, and 990 g/day) respectively. Also, animals receiving yeast culture in the third and fourth stages tended to require less feed per kg of body weight gain than control. A tendency for increased relative growth rate and feed efficiency was observed with camels in the third stage (13.39 &11.91 %) when compared with control (11.04 & 10.68%). The added yeast diets had a significant ($P<0.05$) increase in the apparent digestibility coefficients for dry matter (DM), organic matter (OM), crude protein (CP) and crude fiber (CF); however no significant effects were observed among treatments for ether extract (EE) and nitrogen free-extract (NFE) digestibilities. Yeast culture supplementation improved digestibility by 5.9, 11.7 & 7.5 % for DM; 3.5, 10.6 & 7.3 % for crude protein and by 7.7, 14.1 &12.3 % for crude fiber in the second, third and fourth feeding stages, respectively than control which lead to an increase in the nutritive value (TDNs & DCP). For rumen fermentation, yeast culture addition resulted in a numerical increase in the ruminal pH, ammonia-N and total volatile fatty acids (VFA) concentrations. No significant ($P<0.05$) differences were observed in the blood biochemical parameters including total serum protein, albumin, globulin, glucose, cholesterol, urea and beta-hydroxy butyric acid (BHBA) along the four feeding stages. In conclusion, the results obtained from the current study indicated that, yeast culture supplementation (4g/kg diet) had a positive

effect on the feed intake, growth performance, nutrient digestibility and rumen fermentation of camel calves.

**Key words**: *Performance, digestibility, rumen fermentation, yeast culture, camels.*

# INTRODUCTION

During the last decades, ruminant nutritionists and microbiologists showed great interest in manipulating the microbial ecosystem of the rumen in order to improve the production efficiency and as a solution for the growing concern over the use of antibiotics and other growth promoters in the animal feed industry. As a result, interest in the effects of microbial feed additives on animal performance has increased during the last 20 years. More than 1000 strains of *Saccharomyces cerevisiae* are listed in American Type Culture Collection Catalogue (ATCC) and the apparent activity of these strains have not widely been investigated (Newbold et al., 1995). Robotics have been used as growth promoters to replace the widely used antibiotics and synthetic chemical feed supplements (Higginbotham &Bath, 1993 and Strzetelski, 1996). Dietary supplementation with dry yeast cultures *(Saccharomyces cerevisiae)* was noted to improve the digestibility of dry matter, crude protein and hemicellulose by increasing the rumen bacterial number and outflow rate of microbial nitrogen post ruminally (Wiedmeier et al., 1987; Wallace & Newbold, 1992; El-Waziry et al., 2000; El-Talty et al., 2001; Al-Dabeeb & Ahmed, 2002; Marghany et al., 2005; El-Waziry & Ibrahim, 2007 and Fadel-Elseed & Rania Abousamra, 2007). Adams et al. (1981) and Newbold et al. (1995) observed little effect of yeast supplementation on ruminal pH, ammonia-N, volatile fatty acids concentrations and fiber digestion. However, in contradictory report the addition of yeast has been shown to decrease the concentration of ammonia-N in the rumen, as a result of its direct effect on reducing the degree of protein degradation (El-Waziry et al., 2000; Kamal et al., 2000; Al-Dabeeb & Ahmed 2002; and Eweedah et al., 2005). The most reproducible effect of dietary yeast supplementation is the increase in the bacterial numbers in the rumen, which is the central to the action of the yeast in improving ruminant productivity (Wallace & Newbold, 1992). Yeast has been shown to provide nutrients that stimulate the growth of certain rumen microorganisms such as the lactic acid-utilizing rumen bacterium *Selenomonas ruminatium* (Nisbet & Martin, 1991). The current experiment was designed to study the effect of yeast culture supplementation on dry matter intake, growth

performance, nutrients digestibility and rumen fermentation, in addition to some blood biochemical parameters in growing camel calves.

## MATERIALS and METHODS

### Animals, feeding and housing:

Four-bull dromedary camel calves; of one hump species having about 16 months age and 235 kg average body weight were used in this experiment. The animals appeared to be clinically healthy and the parasitological examination revealed no gastrointestinal infestation. The four animals forming one group, were fed during four-stage period, each of 6 weeks on basal diet supplemented with different levels of dried yeast culture. Each stage was long enough to trace the rate of growth to establish and assess the effect of yeast culture. The last 5 days in each feeding stage were assigned for fecal collection and digestibility determination. During the four-feeding period, animals were fed a completely mixed basal diet containing the recommended requirements for energy (2.23 Mcal ME/kg diet) and crude protein (12.3%) following the nutrient recommendations of Gihad & El-Bedawy (1995) for growing camels. Animals in the first feeding stage were fed on yeast free diet and considered as control to which the digetibilities and performances of the other stages were compared. The animals in the second, third and fourth feeding stages received the same basal ration supplemented with 2, 4, and 6 g yeast/kg mixed diet, respectively.The proximate analysis of feed ingredients, physical and chemical composition of the basal diet are shown in Tables 1 &2.

**Table (1): Chemical composition ( % ) of the feed ingredients used in the basal ration formulation**

| Ingredients | DM | on dry matter basis | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CP | EE | CF | Ash | NFE | ME Mcal/ kg DM | Ca | p |
| **Corn, ground** | 89.4 | 8.8 | 4.7 | 3.1 | 1.6 | 81.8 | 3.11 | 0.03 | 0.27 |
| **SBOM** | 91.3 | 45.9 | 2.4 | 6.7 | 7.3 | 37.7 | 3.15 | 0.35 | 0.68 |
| **Wheat bran** | 89.6 | 16.1 | 4.9 | 10.9 | 7.8 | 60.3 | 2.67 | 0.14 | 1.35 |
| **CCM*** | 88.9 | 13.2 | 3.9 | 21.3 | 9.3 | 52.3 | 2.25 | 1.42 | 0.82 |
| **Wheat straw** | 92.2 | 3.3 | 0.4 | 36.7 | 17.9 | 41.7 | 1.60 | 0.16 | 0.04 |

* CCM = Commercial concentrate mixture.

**Table (2): Physical & chemical composition (%) of the experimental basal ration**

| composition | Experimental basal ration |
|---|---|
| **I-Physical Composition** | |
| Corn, ground | 18.0 |
| Soybean meal | 12.5 |
| Wheat bran | 10.0 |
| CCM | 15.0 |
| Wheat straw | 42.0 |
| Lime stone | 0.8 |
| Common salt | 1.2 |
| Min mixture* | 0.2 |
| $AD_3$ E** | 0.3 |
| **II-Chemical Composition (on dry matter basis)** | |
| Dry matter (%) | 90.98 |
| Crude Protein (%) | 12.3 |
| Ether extract (%) | 2.39 |
| Crude Fibre (%) | 21.09 |
| Ash (%) | 10.89 |
| NFE (%) | 53.33 |
| ME Mcal /kg DM | 2.23 |
| Calcium (%) | 0.64 |
| Phosphorus (%) | 0.41 |

* Mineral mixture : Each 100 g contain: 25.6 g Na, 1.6 g K, 4.6 g Ca, 1.8 g P, 4.0 g Mg, 300 mg Fe, 32 mg Mn, 1.5mg, Cu, 15 mg Iand 1 mg Se ( AGRICO International Company).

** $AD_3$ E: Each gram contains: 20.000 IU vitamin A, 2000 IU vitamin D, 400 IU vitamin E (AGRICO International Company).

Camels were housed in separate pens, managed individually under the prevalent environmental conditions, and fed whole mixed basal ration on ad-libitum basis. The mixed ration was given twice daily at 9.00 a.m and 5.00 p.m and any residues and orts were collected and weighed through the whole stage-feeding period and all animals had free access to clean fresh water.

**Growth performance and feed efficiency:**

Feed intake was daily recorded, and camels were weighed at the beginning and at the end of each stage. The growth was measured and expressed in percentage relative to the body weight in order to compare the different stages in relation to its relative rate of growth. Relative growth rate was calculated according to the following equation:

$$\text{Relative growth rate} = \frac{(W_1 - W_2)}{1/2\,(W_1 + W_2)} \times 100$$ (Crampton & Lloud, 1959).

The amount of feed intake was divided by the body weight gain of the camel in order to calculate the rate of feed conversion. Feed efficiency was calculated according to the following equation:

$$\text{Feed efficiency} = \frac{1}{\text{Feed consumed per kg gain}} \times 100$$ (Krishna Mohan et al., 1987).

## Sampling and analysis of feeds & fecal matter:

Feed ingredients used in the experimental basal ration were sampled, dried, ground and analyzed for different nutrients. Fecal matter were collected from each animal over 5 days at the end of each stage, and representative sample of one kg was interpolated. A solution of 10 % sulphric acid and formalin was added to the collected representative samples. Feed and fecal samples were dried (at 60 °C for feces), mixed and ground, then stored for further analysis. They were analyzed for several chemical components following AOAC (1990) official method.

## Digestibility determination:

Digestibility of the dry matter and other nutrients were estimated using ashless method where acid insoluble ash (AIA) was used as natural indicator (Van-Keulen & Young, 1977). Digestion coefficient (DC) of dry matter and different nutrients were calculated according to the following equations:

$$DC\ of\ DM = \frac{g\ indicator / kg\ feces - g\ indicator / kg\ feed}{g\ indicator / kg\ feces} \times 100$$

(McDonald et al., 1995).

$$DC\ of\ nutrient = 100 - \left\{ 100 \times \frac{\%\ indicator\ in\ feed \times \%\ nutrient\ in\ feces}{\%\ indicator\ in\ feces \times nutrient\ in\ feed} \right\}$$

(Cho et al., 1982).

## Ruminal and blood samples:

Ruminal fluid samples were delivered through esophageal stomach tube at 3 & 6 hours after morning meal on the last 2 days of the experimental stage periods. Samples were strained through double layers cheese cloth and pH was immediately measured with a portable pH meter, then the samples were acidified using concentrated sulphric acid and kept frozen prior to analysis.

Blood samples were taken at the end of each stage before the morning meal from the Jugular vein in a dry, clean and sterile centrifuge tubes. The samples were allowed to be clotted at room temperature. The clotted blood were centrifuged at 3000 rpm for 20 minutes. A clear sera were separated by Pasteur-pipette and transferred into a clean, dry and sterile Stoppard glass vials, freezed at -20 °C till performing the biochemical analysis.

## Estimation of ruminal and biochemical parameters:

Ruminal ammonia-N ($NH_3$-N), total volatile fatty acids (FVA) concentrations were determined by gas liquid chromatography (Inters mat, IGC120 FB). Total serum protein, albumin, globulin, glucose, urea, uric acid, creatinine, and total cholesterol were determined using standard kits supplied by Bio-Merieux ( Baines / France ) .

## 7-Statistical analysis:

Statistical analyses of the collected data were carried out according to procedures of completely random design, SAS (1996).

# RESULTS & DISCUSSION

There is no efficient studies to elucidate the effect of dried yeast (Saccharomyces cerevisiae) on growth performance, nutrient digestibility and rumen fermentation in dromedary camel calves. In this experiment, the effect of yeast supplementation was investigated to study its effect on feed intake, body weight gain (BWG), feed efficiency, digestibility and rumen fermentation in growing camels.

## Intake and growth performance:

As to the dry matter intake (DMI) in the different feeding stages, it was noted that yeast culture supplementation have numerical increase

in DMI (Table 3). Camel calves supplemented with different levels of yeast in the third and fourth feeding stages consumed higher amounts of feed (2.68 & 2.57 kg DM/100kg LBW) compared with control (2.47 kg DM/100kg LBW). The enhancement of DMI by addition of yeast culture in the present study is supported by the findings of Wohlt et al. (1991), Quigely et al. (1992), Wohlt et al. (1998), Lesmeister et al. (2004) and Kim et al. (2006) with dairy calves and Al-Dabeeb & Ahmed (2002), Haddad & Gousous (2005) with sheep and Fadel-Elseed & Rania Abousamra (2007 with Nubian goat's kids. On the other hand, Malcolm & Kiesling (1990) found that feed intake and apparent digestibility of DM was not influenced by live yeast culture addition in steers.

**Table (3): Dry matter intake in the four feeding stages**

| Stages | Kg/100kg LBW | Kg/head/day |
|---|---|---|
| 1 (Control 0 g yeast culture/kg diet) | 2.47±0.27 C* | 6.15±0.52 |
| 2 (2 g yeast culture/kg diet) | 2.53±0.28 bC | 7.05±0.48 |
| 3 (4 g yeast culture/kg diet) | 2.68±0.35 a | 8.45±0.61 |
| 4 (6 g yeast culture/kg diet) | 2.57±0.31 b | 9.20±0.55 |

*Figures in the same rows having the same superscripts are not significantly different (P< 0.05)

Yeast culture supplementation resulted in a significant (P<0.05) increase in final weight gain and average daily gain (ADG) particularly, with those camels supplemented with 4 g yeast/kg diet in the third feeding stage (Table 4).

**Table (4): Performance of growing camels in the four feeding stages**

| Item | Feeding stages | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Initial weight ( kg ) | 235.4±7.61 | 262.9± 9.25 | 294.7± 10.2 | 337.0± 8.9 |
| Final weight ( kg ) | 262.9±9.25 | 294.7± 10.2 | 337.0± 8.9 | 378.6± 9.9 |
| Total weight gain ( kg ) | 27.5±1.31 c* | 31.8± 1.22 b | 42.3± 0.86 a | 41 6± 1.56 a |
| Average daily gain ( g ) | 657±25.8 c | 757± 22.4 b | 1006± 42.5 a | 990± 36.2 a |
| Daily DM intake (kg) | 6.15 | 7.05 | 8.45 | 9.20 |
| Relative growth rate (%) | 11.04 | 11.41 | 13.39 | 11.63 |
| Feed conversion ratio (Kg DM / kg gain) | 9.36 | 9.31 | 8.40 | 9.29 |
| Feed Efficiency (%) | 10.68 | 10.74 | 11.91 | 10.76 |

*Figures in the same rows having the same superscripts are not significantly different (P< 0.05).

Unsupplemented camel calves had lower ADG (657g/day) than those with 2, 4 and 6 g /kg diet yeast supplement (757, 1006 & 990 g/day) respectively. Animals received yeast culture in the third and fourth

stages tended to require less feed per kg of body weight gain than control and camels in the second stage. The total body weight gain in 42-day period on yeast culture supplemented diet reached 42.3 kg, 1.5 times that on unsupplemented diet in spite of the camels age which was 3 months older. A tendency for increased relative growth rate and feed efficiency was observed for camels supplemented with 4 g yeast/kg diet in the third stage (13.39 &11.91 %) when compared with control (11.04 & 10.68%). Improvement of ADG observed in current study agreed with the findings of Walli, (1994), Wohlt et al. (1991, 1998), Lesmeister et al. (2004), Fadel-Elseed & Rania Abousamra (2007). On contrary, Mutsvangwa et al. (1992), Fiems et al. (1995) and El-Hassan et al. (1996) found that feed intake, growth rate and live weight gains were not influenced by yeast supplement in beef bulls. Enhancement of dry matter and fiber digestion, and therefore feed intake in response to supplemental yeast culture may have served in stimulating a production response in term of ADG and growth performance (Haddad & Goussous, 2005 and Marghany et al., 2005)..

## Digestibility of the nutrients:

Table 5 illustrates the apparent digestion coefficients of the dry matter and the different nutrients, in addition to nutritive value (TDNs and DCP) in the four stage periods.

**Table (5): Digestion coefficient of the nutrients and nutritive value (%) of the experimental diet as affected by addition of yeast culture**

| Nutrients | Feeding stages | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| **Digestion coefficient:** | | | | |
| Dry matter | 61.3± 1.35 $^{c}$ | 65.13± 1.28 $^{b}$ | 69.42± 2.01 $^{a}$ | 66.25± 1.92 $^{b}$ |
| Organic matter | 63.57± 1.6 $^{c}$ | 65.96± 1.46 $^{b}$ | 70.73± 1.85 $^{a}$ | 67.36± 1.88 $^{b}$ |
| Crude protein | 65.12± 1.72 $^{b}$ | 67.45± 1.7 $^{b}$ | 72.82± 1.77 $^{a}$ | 70.25± 1.6 $^{a}$ |
| Ether extract | 64.86± 1.25 | 64.7± 1.33 | 65.41± 1.62 | 65.11± 1.38 |
| Crude fiber | 58.7± 1.18 $^{c}$ | 63.6± 1.62 $^{b}$ | 68.30± 1.65 $^{a}$ | 66.9± 1.49 $^{a}$ |
| Nitrogen free-extract | 63.80± 1.9 | 64.19± 1.81 | 64.70± 1.52 | 63.86± 1.76 |
| **Nutritive value:** | | | | |
| **TDNs** | 58.24± 1.12 | 59.81± 1.23 | 61.75± 1.43 | 60.73± 1.45 |
| **DCP** | 8.01± 0.35 | 8.30± 0.36 | 8.96± 0.52 | 8.64± 0.48 |

*Figures in the same rows having the same superscripts are not significantly different (P< 0.05).

The added yeast diets had a significant (P<0.05) increase in the digestibility coefficients for DM, OM, CP and CF, however no significant effects were observed among treatments for EE and NFE digestibilities. Yeast culture supplementation improved digestibility by 5.9, 11.7 & 7.5 % for DM; 3.5, 10.6 & 7.3 % for crude protein and by 7.7, 14.1 &12.3 % for crude fiber in the second, third and fourth feeding stages, respectively than control. The effect was significant (P<0.05) and more pronounced with high levels of yeast (4 & 6 g yeast/kg diet) in the third and fourth stages. The general positive effect of YC addition on the apparent digestibility of most nutrients is in agreement with results obtained by Wiedmeier et al. (1987), Williams et al. (1991), Carro et al. (1992), Harris et al. (1992), Putnam et al. (1997), Robinson (1997), Wohlt et al. (1998), Al-Dabeeb & Ahmed (2002), El-Waziry & Ibrahim (2007) and Fadel-Elseed & Rania Abousamra (2007) who reported that YC supplementation improved the digestibility coefficients of most nutrients. Also, the results of CF digestibility in the current study are supported by the findings of Wohlt et al. (1998), El-Talty et al. (2001), Kholif etal. (2005), Marghany et al. (2005), Kholif & Khorshed (2006) and El-Waziry & Ibrahim, (2007). On the other hand, Mutsvangwa et al. (1992) found no effect for YC addition on the apparent digestibility of DM, OM, CP, and ND in beef bulls.

The benefits associated with *Saccharomyces cerevisiae* include increased DM and CF digestion may be attributed to the increase of numbers of rumen total viable bacteria and thus increase in cellulolytic bacteria when yeast cultures were added to mixed diets for ruminants (Weidmeier et al., 1987; Dawson & Newman, 1988; Dawson, 1993 and Newbold et al., 1996). The mode of action of the yeast as well as other bacteria can be quite variable, ranging from enhanced cellulolytic bacteria proliferation by providing unknown growth factor to increase substrate availability through added enzymatic digestion (Martin & Nesbit, 1992).

The increase digestibility leads to an increase in the feeding value including total digestible nutrients (TDNs) and digestible crude protein (DCP) as shown in Table 5. TDNs increased from 58.24 % in the first stage (control) to 59.81, 61.75 and 60.73 % in the second , third and fourth feeding stages, respectively due to yeast addition and the same trend was found for DCP.

## Rumen fermentation parameters:

To clarify the mode of action of yeast culture, ruminal microbial activity was evaluated as pH, ammonia-N and total volatile fatty acids concentrations (Table 6).

**Table (6): Rumen pH, VFA and ammonia-N of growing camels in the four feeding stages**

| Parameters | Feeding stages | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| PH | 6.24± 0.04 | 6.48± 0.06 | 6.62± 0.08 | 6.58± 0.05 |
| Volatile fatty acids (VFA) (mmol/dl) | 10.8± 0.92 | 11.2± 0.89 | 11.6± 0.76 | 10.9± 0.85 |
| Ammonia-N (mg/dl) | 12.9± 1.12 | 14.1± 1.06 | 14.4± 1.10 | 13.8± 0.99 |

Yeast culture resulted in a slight increase in the ruminal pH, ammonia-N and total volatile fatty acids concentrations, however no significant ($P<0.05$) effects were observed among treatments. Zelenak et al. (1994); Yoon & Stern (1996); Putnam et al. (1997), Miler-Webster et al. (2002) and Fadel-Elseed & Rania Abousamra (2007 have reported similar results. However, Piva et al. (1993), Fiems et al. (1995) and Galip (2006) found that, total volatile fatty acids, ammonia-N and protozoa counts in the ruminal fluid were not affected by yeast culture addition in rams. On the contrary, Harrison et al. (1988), Enjalbert et al. (1999), Kumar et al. (1999), El-Waziry et al. (2000), Kamal et al. (2000), Al-Dabeeb & Ahmed (2002) and Eweedah et al. (2005) have observed a reduction in ammonia-N concentration to reach the minimum at 6-hour post-feeding as a result of its direct effect on reducing the degree of protein degradation. Slight increase in the rumen pH, ammonia-N and VFA concentration may be due to increase in both bacterial counts and activity (Erasmus et al., 1992; Yoon & Stern, 1996; and Putnam et al., 1997) and the stability of the rumen environment. The difference between results of this study and other published data (Hadjipanayiotou et al., 1997) could be attributed to differences in quantities used and/or different strain of yeast culture.

## Blood biochemical parameters:

No significant ($P<0.05$) differences were observed in the blood biochemical parameters including total serum protein, albumin, globulin, glucose, cholesterol, urea, uric acid AND creatinine among animals in the four feeding stages (Table 7).

**Table (7): The blood serum biochemical parameters of growing camels in the four feeding stages**

| Parameters | Feeding stages | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Total protein ( g/dl ) | 7.37±0.48 | 7.56±0.54 | 7.84±0.61 | 7.64±0.52 |
| Albumin (g/dl ) | 3.56±0.28 | 3.89±0.31 | 4.12±.0.26 | 3.76±0.39 |
| Globulin ( g/dl ) | 3.47±0.35 | 3.63±0.0.28 | 3.62±0.18 | 3.59±0.24 |
| Urea ( mg /dl) | 10.9±0.76 | 11.6±0.66 | 11.3±0.79 | 10.8±0.82 |
| Uric acid (mg/dl) | 0.24±0.02 | 0.25±0.03 | 0.29±0.01 | 0.27±0.02 |
| Creatinine (mg/dl) | 2.15±0.2 | 2.16±0.4 | 2.12±0.2 | 2.09±0.3 |
| Glucose (mg /dl ) | 125.2±4.3 | 130.6±3.6 | 132.±4.5 | 129.0.± 2.9 |
| Cholesterol ( mg /dl) | 149.0±5.2 | 145.0±4.8 | 146.0±6.2 | 148.0±4.7 |

These values are consistent with expected values for camel calves of this age. These results are in agreement with that found by Piva et al. (1993), Francisco et al. (2002), Ghorbani et al. (2002) Lemeister et al. (2004) and Galip (2006) who recorded no effects of yeast culture on any blood variables in feedlot cattle. Yadav et al. (1994) found that blood glucose level was not influenced by supplemental feeding of yeast culture, while plasma protein level was significantly higher than control in female buffalo calves.

In conclusion, the results obtained from the current study indicated that, yeast culture supplementation (4g/kg diet) had a positive effect on the feed intake, growth performance, nutrient digestibility and rumen fermentation of camel calves.

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