EFFECT OF DIETARY LIVE YEAST *(SACCHAROMYCES CEREVISIAE)* SUPPLEMENTATION ON SOME PRODUCTIVE TRAITS AND METHANE PRODUCTION OF LACTATING BUFFALOES UNDER HEAT STRESS

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SUMMARY

The aim of the present study was to investigate the effect of yeast supplementation *(Saccharomyces cerevisiae MUCL* 39885, Probio-Sacc®, Biochem, Lohne, Germany) on performance and methane production of dairy buffaloes under heat stress. Ten Egyptian lactating buffaloes with an average live body weight 585 ±30 kg, in their 3rd or 4th lactation seasons and at 90±10 days in milk were randomly assigned into two nutritional groups each of 5 animals. The first group served as a control (G1), while the second group (G2) was individually supplemented with 5 g probiotics per head per day. Each 1 g of Probio-Sacc® contained 1.5 x 10^{10} *CFU* live *Saccharomyces cerevisiae MUCL* 39885.The experimental period lasted for 90 days. Experimental animals were housed in semi-opened pens under an ambient temperature and relative humidity ranged from 23.3 - 34.4 ^{o}C and 21.1 - 69.3 %, respectively and offered their daily requirements according to NRC (2001). Total milk yield (TMY), Milk fat content (MF), milk protein content (MP), Milk total solids (TS), Solids not fat (SNF), Lactose content (ML) and 7% fat corrected milk yield (FCMY) were measured in each group. Temperature humidity index (THI) values ranged from 77.31 to 80.41, indicating that experimental animals were under moderate to severe heat stress during the experimental period. Average total milk yield, (FCMY) and (MF) were higher ($P \leq 0.05$) in yeast group than the control. milk protein, milk ash, (ML), (TS) and (SNF) tended to be higher insignificantly in yeast supplemented group, but the effect was not significant. Meanwhile, somatic cell count was insignificantly lower in LY treated group than in the control group. Live yeast treatment had no significant effect on total methane production per day but reduced the methane production per kg milk production as compared with the control group. It can be concluded that live yeast supplementation ameliorated the effect of heat stress on buffalo milk production and composition, although it tended to increase methane production due to the increase in dietary dry matter intake. It improved buffaloes milk production, net revenue and animals feed efficiency through different climate changes, by reducing methane production per kg milk production.

Keywords*: Dairy buffalo, yeast, heat stress, milk production and composition, methane emission*

INTRODUCTION

Heat stress and methane production are some important challenges in cattle rearing (FAO 2003, St-Pierre *et al*. 2003). The economic loss due to reduced milk production, reproductive efficiency, and animal health during hot seasons is a major issue for the dairy industry worldwide (St-Pierre *et al*. 2003). Heat stress negatively affects productivity and longevity of dairy cows (Kadzere *et al*. 2002), may be due to negative energy balance under heat stress (Moore *et al*. 2005) as a result of increasing energy demand for maintenance (NRC 1981) and energy expenditure for homeothermic regulation (Fuquay 1981) causing a reduction in feed efficiency (Britt *et al*. 2003). Heat stress may also reduce daily rumination time (Soriani *et al*. 2013), saliva production and ruminal motility (Silanikove 1992), blood flow to the digestive tract (McGuire *et al*. 1989), as well as digesta fractional passage rate (Schneider *et al*. 1988). One of the most important challenges of producing milk in hot humid climates is the decline in milk yield due to reduction in dry matter intake (DMI) as approximately 50% of the reduction in milk production has been attributed to a decline in voluntary DMI (Wheelock *et al*. 2010).

Dietary yeast supplementation increased ($P \leq 0.05$) milk production during heat stress, may be due to increased dry matter intake and feed efficiency (Bruno *et al*. 2009, Moallem *et al*. 2009). Meanwhile, (Li *et*

al. 2021) reported that, although dry matter intake did not affect by active dry yeast (ADY) supplementation, the yield of actual milk, 4% fat-corrected milk, milk fat yield, feed efficiency, milk protein and lactose increased with increasing ADY doses, whereas somatic cell count decreased quadratically. They concluded that feeding ADY to early lactating cows improved lactation performance by increasing nutrients digestibility. The effect of yeast supplementation on milk composition was conflicting, where some studies had shown that yeast culture had no beneficial effect on dairy cows' milk composition (Bagheri *et al*. 2009), while (Majdoub-Mathlouthi *et al*. 2009) and (Dehghan-Banadaky *et al*. 2013) claimed that fat and protein percentages were higher with yeast supplementation during the hot season. Moreover, (Bakr *et al*. 2015, Sretenović *et al*. 2008, Stein *et al*. 2006) reported that milk somatic cell count was also decreased in yeast-supplemented cows compared with that of the controls. The reduction of SCC in yeast-treated cows may be attributed to a better health status of their udder (Sretenović *et al*. 2008) or may be due to an improvement of the immune status of the yeast-supplemented cows, as a result of the increase in IgA and secretory components of immunoglobulins (Buts *et al*. 1990).

Methane production from ruminant has two main effects: its effect on productivity and on climate changes as a greenhouse gas. (Moss *et al*. 2000) reported that methanogens consumed 2-15% of ingested energy from ruminants during methane production. (Kumar *et al*. 2009) added that high levels of methanogenesis in the rumen led to reduce productivity and had negative impacts on the ability of ruminants to sustain high levels of production. Regarding its effect on climate changes, societal concerns exist regarding ruminant enteric methane emissions contributing to the greenhouse effect, which has also fueled interest in reducing this source of methane (Moss *et al*. 2000). Projections predict that, if methane emissions continue to rise in direct proportion to livestock number, there will be an expected 60% increase in global methane production in the next 30 years (FAO 2003, Lassey and Ulyatt 2000). Probiotic species, such as *Saccharomyces cerevisiae* and *Aspergillus oryzae* have been found to reduce methane emissions (Boadi *et al*. 2004). Also, in vitro studies showed that *A. oryzae* and *S. cerevisiae* were able to reduce methane emissions by 50% and 10%, respectively) (Mutsvangwa *et al*. 1992). However, (Li *et al*. 2021) found that methane production was not affected by active dry yeast (ADY) supplementation when expressed as grams per day or per kilogram of actual milk yield, dry matter intake, digested organic matter, and digested non fiber carbohydrate, whereas a trend of linear and quadratic decrease of CH_4 production was observed when expressed as grams per kilogram of fat-corrected milk and digested neutral detergent fiber.

The objectives of the present study are to evaluate the effects of dietary supplementation with live yeast (*S. cerevisiae*) as a probiotic on lactating buffalo production and methane mitigation under heat stress.

MATERIALS AND METHODS

The present study was carried out at the experimental farm station belongs to the Faculty of Agriculture, Al-Azhar University, Mostorod, Qalyubia Governorate, Egypt, through the period from June 2017 to August 2017.

Animals feeding and management:

Ten Egyptian lactating buffalo with an average live body weight 585 ±30 kg, in their 3rd or 4th lactation seasons and at 90±10 days in milk were randomly assigned into two nutritional groups each of 5 animals. The first group served as a control (G1), while the second group (G2) was individually supplemented with 5 g probiotics per head per day (Probio-Sacc®, Biochem, Lohne, Germany). Each 1 g of Probio-Sacc® contained a live yeast *Saccharomyces cerevisiae MUCL* 39885 1.5 x 10^{10} *CFU*.

During the experimental period, the farm's routine health management was followed and animals having any health disorders were excluded from the study.

The experimental period lasted for 90 days. Experimental animals were housed in semi-opened pens under an ambient temperature and relative humidity ranged from 23.3 - 34.4 C^{o} and 21.1 - 69.3 % respectively. They offered their daily lactation requirements according to NRC (2001). Concentrate feed mixture (15 % CP and 65 % TDN) + rice straw was offered to lactating Buffalo cows in two equal meals at 9.00 am and 3.00 pm, meanwhile, a free access to fresh drinking water was available.

Total milk yield (TMY) of the two experimental buffalo groups was recorded daily for 90 days interval. Experimental animals were hand-milked twice daily at 12 hours intervals *i.e.,* 6:00 and 18:00 and samples

from each milking were collected. A composite sample was kept stored frozen at -20°C for later chemical analysis. Milk fat content (MF) was determined according to Gerber methods as described by (Ling 1956), milk protein content (MP) was determined by the semi-micro-Kjeldahl distillation technique according to (Ling 1963), Milk total solids (TS) were determined in a 10 ml milk sample to a constant weight at 105°C for 6 hours, according to (AOAC 1980), solids not fat (SNF) were calculated by the difference between total solids and fat content, Lactose content (ML) was determined colorimetrically according to the method of (Barnett and Tawab 1957) and the 7% fat corrected milk yield (FCMY) was calculated according to the following formula (Rafat and Saleh 1962):

$$FCMY\ (kg) = 0.265 \times milk\ yield + 10.5 \times fat\ yield$$

Somatic cell counts (SCC) were determined by Bentley Soma Count 150 according to Zecconi *et al.* (2002). Methane production was calculated using equation of Ramin and Huhtanen, (2013) as:

$$CH_4\ (L/d) = 62 + 25.0 \times DMI$$

Statistical analysis:

SPSS Statistics, version 25 (2017) was used to analyze different studied traits in both the control and the live yeast-fed groups using an independent t-test. The statistical model was: $Y_{ij} = \mu + R_i + e_{ij}$

where: μ = overall mean R_i = fixed effect of traits (i = control, live yeast) e_{ij} = residual error term

difference was declared as significant when ($P \leq 0.05$). Data are presented as means ± standard errors

RESULTS AND DISSCUSION

Meteorological data:

Values of ambient temperature (Ta), relative humidity (RH), and temperature humidity index (THI) from June to August 2017 were presented in (Table 1). Results showed that the mean temperature humidity index (THI) values ranged from 77.31 to 80.41, respectively. This range of THI indicated that animals in the present study were under moderate to severe heat stress during the experimental period according to Weather Safety Index categories (Davis *et al*. 2003, Fuquay 1981).

Table (1): Mean ambient temperature (^{o}C), relative humidity (%) and temperature humidity index during the experimental period.

Month	Temperature (° C)			Humidity (%)			THI		
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
June	35.27	23.83	29.34	79.03	25.17	49.81	91.1	67.84	77.31
July	36.52	25.9	30.96	84.58	28.1	55.76	94.32	70.35	80.41
August	35.39	25.26	30.42	83.97	32.16	59.04	92.33	70.1	80.19

Milk production and composition parameters:

Milk production:

Data presented in (Table 2) showed that, there were significant differences ($P<0.05$) in daily milk yield among live yeast group (LY) in compare with the control one. such differences between groups were more obviously ($P \leq 0.05$) at the 2nd and 3rd months of the experiment, but without significant difference during the 1st month. Similar trend among treatments was observed in FCMY. The above results indicated that dietary *S. cerevisiae* yeast supplementation increased ($P \leq 0.05$) average total milk yield and fat corrected milk yield of lactating buffalos during mild to severe heat stress. These results agreed with (Dias *et al*. 2018, Moallem *et al*. 2009, Nasiri *et al*. 2019, Oh *et al*. 2019, Salvati *et al*. 2015) who found that dietary yeast supplementation increased milk production during the warm summer months. (Perdomo *et al*. 2020) indicated that increased yield of energy-corrected milk might be related either to direct effects of LY on ruminal microbial activity or to changes in feeding behavior that improved digestion in cows under heat stress conditions. (Mahrous *et al*. 2019) suggested that improvement in the milk yield of cows after

supplemented fed by live yeast, might be referred to an improved protein status, an improved intake of net energy of lactation, or both. (Mousa *et al*. 2012) concluded that an improvement in milk production due to live dry yeast (DY) supplementation could be attributed to increasing nutrients digestibility of the experimental diets with DY addition and hence improved nutritive values of tested diets and the productive performance in general. (Huber 1998) suggested that increased DMI and milk production when cows were fed on yeast during periods of heat stress, possibly reflecting the role in aiding appetite during the time of stress. On the other hand, (Dehghan-Banadaky *et al*. 2013) reported that *S. cerevisiae* supplementation did not enhance milk production in dairy cows than in control when cows were cooled three times a day during the study period which might indicate that the beneficial effect of yeast supplementation is more pronounced during heat stress in lactating cattle. Also, using *Saccharomyces cerevisiae* live cells and *Aspergillus oryzae* fermentation extract supplementation had no significant effect on milk production ((Sallam *et al*. 2020).

Table (2): Average of daily actual milk production and 7% fat corrected milk yield for buffalo cows during the experimental period.

Actual milk production (kg/d)					
Item	G1		G2		
	Mean	S.E.	Mean	S.E.	P
1st month	4.785	0.166	5.102	0.137	NS
2nd month	4.417	0.153	4.956	0.133	*
3rd month	3.781	0.12	4.231	0.096	*
Overall mean	4.328	0.14	4.763	0.119	*
Fat correct milk 7 % (kg/d)					
1st month	4.7242	0.182	5.1744	0.124	NS
2nd month	4.3191	0.172	5.0018	0.112	*
3rd month	3.7067	0.129	4.2499	0.092	*
Overall mean	4.2485	0.152	4.8073	0.105	*

*S.E.: Standard error G1: Control G2: Live yeast *: Significant at P≤0.05*
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Milk fat:

Results of milk fat are presented in (Table 3). Results indicated that mean percentage of milk fat was higher ($P \leq 0.05$) in LY group than the control during the whole experimental period, except the first month where the effect was insignificant. The significant effect of treatments on milk fat is agreed with (Majdoub-Mathlouthi *et al*. 2009, Nasiri *et al*. 2019) who found that cows receiving yeast had greater concentrations of milk fat than those not receiving yeast under summer's hot months. Also, (Elghandour *et al.,* 2022) concluded that, supplementation of yeast had been shown to promote milk fat and milk production in dairy cows. Meanwhile, (Dehghan-Banadaky *et al*. 2013, Gaafar *et al*. 2009) reported that monthly fat percentage was insignificantly greater for cows receiving LY group than the control. Also, (Desnoyers *et al*. 2009) showed that in the meta-analysis of over 110 papers and 157 experiments, yeast supplementation tended to increase milk fat content. The increase in milk fat by live yeast supplementation may be due to its effect on rumen fermentation, where acetate concentrations might be one of the reasons for increasing milk fat percentage of cows (Dehghan-Banadaky *et al*. 2013). On the other hand, (Oh *et al*. 2019) and (Sallam *et al*. 2020) reported that *S. cerevisiae*-based direct-fed microbial product (SDM) or *Saccharomyces cerevisiae* live cells and *Aspergillus oryzae* fermentation extract had no effect on milk fat compared with the control.

Milk protein:

Data presented in (Table 4) showed that mean percentage of milk protein did not differ significantly between groups, but it tended to be higher in LY group than in the control one during the 2nd and 3rd months of experimental period. (Moallem *et al*. 2009, Oh *et al*. 2019) indicated that *S. cerevisiae* had no significant effect on the concentrations and yields of true protein, compared with the control. The tendency of higher milk protein in LY than the control was in agreement with Perdomo *et al.,* (2020) who reported that milk true protein tended (P = 0.08) to increase with increasing dose of LY while actual protein yield increased (P

< 0.01) linearly with increasing amount of LY. The increase in milk protein with LY supplementation was in accordance with (Majdoub-Mathlouthi *et al*. 2009) who found that protein percentages and yield was higher with yeast supplementation during the hot season.

Table (3): Average milk fat (%) and yield (kg/d) for buffalo cows during the experimental period.

Milk Fat %					
Item	G1		G2		
	Mean	S.E.	Mean	S.E.	P
1st month	6.78	0.07	7.03	0.11	NS
2nd month	6.87	0.05	7.14	0.06	*
3rd month	6.81	0.07	7.04	0.05	*
Overall mean	6.82	0.05	7.07	0.07	*
Milk Fat kg/d	0.3	0.01	0.34	0.01	*

*S.E.: Standard error G1: Control G2: Live yeast *: Significant at P≤0.05*
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Table (4): Average milk protein (%) and yield (kg/d) for buffalo cows during the experimental period.

Milk protein %					
Groups	G1		G2		
	Mean	S.E.	Mean	S.E.	P
1st month	4.55	0.16	4.51	0.1	NS
2nd month	4.48	0.15	4.71	0.07	NS
3rd month	4.42	0.12	4.71	0.09	NS
Overall mean	4.48	0.13	4.64	0.07	NS
Milk protein kg/d	0.19	0.01	0.22	0.01	NS

S.E.: Standard error G1: Control G2: Live yeast
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Milk ash:

Results in (Table 5) indicated that LY supplementation decreased insignificantly ash content during the whole experimental period. These results agreed with (Gaafar *et al*. 2009) who found that the contents of all milk constituents, except ash increased (P<0.05) with baker's yeast. Also, (Sallam *et al*. 2020) found that *Saccharomyces cerevisiae* live cells and *Aspergillus oryzae* fermentation extract supplementation did not affect milk composition compared with the control.

Table (5): Average milk ash (%) and yield (kg/d) for buffalo cows during the experimental period.

Milk ash %					
Group	G1		G2		
	Mean	S.E.	Mean	S.E.	P
1st month	0.73	0.04	0.66	0.02	NS
2nd month	0.75	0.03	0.68	0.03	NS
3rd month	0.74	0.03	0.66	0.02	NS
Overall mean	0.74	0.03	0.67	0.02	NS
Milk ash kg/d	0.03	0	0.03	0	NS

S.E.: Standard error G1: Control G2: Live yeast
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Milk lactose:

Results herein indicated that milk lactose did not differ between LY and control group (Table 6). However, previous results in dairy cows showed that LY increased insignificantly (Dehghan-Banadaky *et al*. 2013, Perdomo *et al*. 2020) or significantly (AlZahal *et al*. 2014, Moallem *et al*. 2009, Schingoethe *et al*. 2004, Yuan *et al*. 2015) milk lactose percentage which might be due to breed differences between lactating cows and buffaloes.

Table (6): Average milk lactose (%) and yield (kg/d) for buffalo cows during the experimental period.

Milk lactose %					
Group	G1		G2		
	Mean	S.E.	Mean	S.E.	P
1st month	3.82	0.13	4.05	0.33	NS
2nd month	3.85	0.18	3.83	0.27	NS
3rd month	3.64	0.16	3.6	0.17	NS
Overall mean	3.77	0.14	3.83	0.25	NS
Milk Lactose kg/d	0.16	0	0.18	0.01	NS

S.E.: Standard error G1: Control G2: Live yeast
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Milk total solids:

Results presented in (Table 7) indicates that milk total solids percentage tended to be insignificantly higher in live yeast treatment than the control group. These results are in agreement with (Dehghan-Banadaky *et al*. 2013) who reported that live yeast supplementation on mid lactation dairy cows during hot season increased total solids percentage numerically. Also, (Schingoethe *et al*. 2004) reported that cows supplemented with yeast culture had numerically higher milk components during summer. Meanwhile, average total solids yield per day was higher (P<0.05) in LY than in the control group. These results are in accordance with (Salvati *et al*. 2015) who found that yeast supplementation increased (P<0.05) milk solids by 0.14 kg/d. The higher milk TS in live yeast treatment than the control might be referred to the higher milk yield and milk fat content in live yeast group than the control, which consequently was reflected in increasing (P<0.05) milk TS.

Table (7): Average milk total solids (%) and yield (kg/d) for buffalo cows during the experimental period.

Milk TS %					
Group	G1		G2		
	Mean	S.E.	Mean	S.E.	P
1st month	15.88	0.21	16.25	0.3	NS
2nd month	15.87	0.19	16.25	0.22	NS
3rd month	15.66	0.19	16.11	0.19	NS
Overall mean	15.8	0.2	16.2	0.23	NS
Milk TS kg/d	0.68	0.02	0.77	0.02	*

*S.E.: Standard error G1: Control G2: Live yeast *: Significant at P≤0.05*
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Milk solids not fat:

The effect of live yeast on milk SNF was similar to their effect on milk TS, where SNF tended to be insignificantly higher in live yeast group than the control (Table, 8). These results are in agreement with (Dehghan-Banadaky *et al*. 2013) who reported that, live yeast supplementation on mid lactation dairy cows during hot season increased solids not fat percentage and yield numerically. Similar results were found in dairy cows by (Schingoethe *et al*. 2004). However, (Sallam *et al*. 2020) found that *Saccharomyces cerevisiae*

live cells and *Aspergillus oryzae* fermentation extract supplementation didn't affect milk composition compared with the control. On the other hand, (Gaafar *et al*. 2009) found that milk solids not fat increased (P<0.05) with baker's yeast supplementation to buffaloes ration.

Table (8): Average milk solids not fat (%) and yield (kg/d) for buffalo cows during the experimental period.

Milk SNF %					
Group	G1		G2		
	Mean	S.E.	Mean	S.E.	P
1st month	9.1	0.19	9.22	0.35	NS
2nd month	8.99	0.17	9.11	0.25	NS
3rd month	8.85	0.17	9.07	0.22	NS
Overall mean	8.98	0.17	9.13	0.27	NS
Milk SNF kg/d	0.39	0.01	0.43	0.01	*

*S.E.: Standard error G1: Control G2: Live yeast *: Significant at P≤0.05*
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Somatic cell count (SCC):

Table (9) Data indicated that SCC was insignificantly lower in LY treated group than the control group. These results are in accordance with (Bakr *et al*. 2015, Sretenović *et al*. 2008, Stein *et al*. 2006) who reported that milk somatic cell count was decreased in yeast-supplemented cows compared with that of the control. (Gao *et al*. 2020) added that, milk SCC in groups supplemented with 8 g yeast; and 8 g/day lactic acid bacteria (LAB) and supplemented with 4 g yeast and 4 g/day (LAB) was lower (P < 0.05) compared with control mastitis on day 20 and day 40. Also, (Lim *et al*. 2021) reported that somatic cell counts were reduced by feeding *Saccharomyces cerevisiae* culture fluid (SCCF) (p < 0.05) in dairy cows under heat stress. On contrarily, (Dias *et al*. 2018) and (Nasiri *et al*. 2019) found that yeast supplementation had no effect on SCC during hot season. The reduction in SCC with yeast-treated cows might be attributed to the better health status of their udders (Sretenović *et al*. 2008) or might be referred to an improved immune status of the yeast supplemented cows, as a result of the increase in IgA and secretory components of immunoglobulins (Buts *et al*. 1990).

Table (9): Effect of live yeast supplementation on milk somatic cell count (SCC) for lactating buffalo.

SCC (cells/mL)				
G1		G2		
Mean	S.E.	Mean	S.E.	P
170200	8896.07	154200	7472.62	NS

S.E.: Standard error G1: Control G2: Live yeast
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Effect of live yeast supplementation on CH_4 production of lactating buffaloes:

Results in (Table 10) showed that live yeast treatment didn't have significant effect on total methane production per day, but live yeast supplementation reduced methane emission / kg milk production compared with the control group. The insignificant effect of live yeast supplementation on methane production is in accordance with the results of (Oh *et al*. 2019) who found that live yeast treatments did not affect enteric methane production, yield (methane / kg dry matter intake) or intensity (methane / kg of energy corrected milk yield). However, (Hristov *et al*. 2010) reported that methane can be reduced by live yeast, and it is dependent on the strain of live yeast used such result was in accordance with the present results concerning the reduced methane production / kg milk production in LY. (Chaucheyras-Durand *et al*.

2008, Newbold and Rode 2006) indicated that yeast cultures, exerting positive influence in mitigating methane emissions from the ruminants, through modification of rumen fermentation, stimulating acetogens to outcompete or co-metabolize hydrogen with methanogens, as well as, also enhancing ruminal conversions of ammonia into microbial protein and improving usage of dietary nitrogen. A lower acetate to propionate ratio is desirable energetically; as the acetate to propionate ratio decreases, the amount of methane emitted into the environment is reduced (Russell 1998) and when acetate is produced, H_2 is produced and converted to methane (Ferry 1992). Moreover, (Chaucheyras-Durand *et al*. 2008) concluded that the mechanism whereby yeast might decrease CH_4 production is uncertain, but it is possibly related to the increase in bacterial numbers that typically occurred due to added yeast. Also, the partitioning of degraded carbohydrate between microbial cells and fermentation products might alter the production of hydrogen, thereby decreasing CH_4 yield (Newbold and Rode 2006). Alternatively, yeast may promote the growth of acetogenic bacteria which are capable of using hydrogen in the rumen (Beauchemin *et al*. 2009).

Table (10): Effect of live yeast supplementation on methane production for lactating buffalo.

Methane production					
Group	G1		G2		
	Mean	S.E.	Mean	S.E.	P
CH_4 (L/DMI/d)	417.25	8.26	418.5	8.93	NS
CH_4 (L/kg milk)	96.95	4.38	88.17	3.39	NS

S.E.: Standard error G1: Control G2: Live yeast
P= Probability level for the effect of treatment NS: Insignificant (P>0.05)

Effect of live yeast supplementation on daily feed intake and feed efficiency:

Data presented in (Table 11) showed that, although live yeast supplementation tended to increase DMI/h/d of rice straw and lower concentrate feed mixture than the control group, the average daily feed intake and feed unit intake expressed as kg DM, TDN, or DCP head/d didn't differ significantly between both the control and live yeast groups. Meanwhile, all daily unit feed intake and efficiency tended to be

Table (11): average daily feed intake and efficiency for lactating buffalo.

Item	Ration	
	Control	Live yeast
No. of animal	5	5
Av. Live body weight (kg)	590	580
Average daily feed intake kg. (on DM basis)		
Concentrate feed mixture	6.75	6.35
Rice straw	7.46	7.92
Av. daily feed unit intake (kg)		
DM (Kg /head/d)	14.21	14.27
TDN (Kg /head/d)	7.3	7
CP (Kg /head/d)	1.39	1.35
DCP (Kg /head/d)	0.83	0.79
Av. daily actual milk yield (kg)	4.33^{b}	4.76^{a}
Av. FCMY (kg)	4.25^{b}	4.81^{a}
Feed efficiency with actual milk:		
DM (Kg)/milk yield (Kg)	3.28	2.99
TDN(Kg) / milk yield (Kg)	1.69	1.47
DCP(Kg) / milk yield (Kg)	0.19	0.17
Feed efficiency with FCMY:		
DM (Kg)/ FCMY (kg)	3.35	2.97
TDN(Kg) / FCMY (kg)	1.72	1.46
DCP(Kg) / FCMY (kg)	0.2	0.16

a and b: Mean with different superscripts in the same rows are significant at P≤ 0.05.

lower in yeast supplemented group than the control one. The present results agreed with (Oh *et al*. 2019, Perdomo *et al*. 2020) who found that (*S. cerevisiae* based direct-fed microbial product SDM) increased milk yield without affecting DMI or feed efficiency.

***Effect of live yeast supplementation on feed cost and economic efficiency*:**

Table (12) indicated that the net revenue (as LE Kg milk yield or / Kg FCMY) was higher for LY group than the control group due to lower dietary feed costs and higher daily milk production in LY group. Accordingly, feed efficiency was better in LY group by about 11% than the control. Improvements in lactation performance, and feed efficiency had been reported in response to yeast supplementation of heat-stressed cows by (Bruno *et al*. 2009, Moallem *et al*. 2009)

Table (12): Average feed cost and economical efficiency for lactating buffalo cows fed different experimental rations.

Item	Ration	
	Control	Live yeast
Av. daily feed intake, as fed, (Kg/head):		
Concentrate feed mixture (CFM)	7.5	7.05
Rice straw	8.2	8.7
Av. daily actual milk yield (kg)	4.33	4.76
Av. FCMY (kg)	4.25	4.81
*Feed cost and economic efficiency:		
Costs of feed intake (LE/head)	33.96	33.72
Selling market price of milk yield (LE/head)	43.28	47.63
Daily feed cost/kg milk yield (LE)	7.85	7.08
Daily feed cost/ FCMY (LE)	7.99	7.01
Net revenue (LE)/h/d	9.32	13.91
Net revenue/ kg milk yield	2.15	2.92
Net revenue/ FCMY (kg)	2.19	2.89
Economical efficiency	1.27	1.41
Improvement of economic efficiency (%)	100	110.834

** Based on the assumption that the price of one ton of concentrate feed mixture, rice straw and live yeast was 4200, 300 and 300000 LE, respectively, while the price of one kg milk yield as selling was 10 LE.*

CONCLUSION

In conclusion, dietary live yeast supplementation for lactating buffaloes during heat stress increased ($p < 0.05$) buffalo cows daily milk production and milk fat and insignificantly dairy buffalo cow milk composition, net revenue, feed efficiency, besides reducing methane emission per kg milk production.

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تأثير إضافة الخميرة الحية *Saccharomyces cerevisiae* على بعض الصفات الانتاجية للجاموس الحلاب وكمية الميثان المنبعث تحت ظروف العبء الحراري

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اجريت هذه الدراسة بمحطة البحوث الزراعية التابعة لقسم الإنتاج الحيواني بكلية الزراعة جامعة الأزهر – مسطرد – محافظة القليوبية خلال الفترة من يونيو ٢٠١٧م وحتى أغسطس ٢٠١٧م. بهدف دراسة تأثير الخميرة الحية على آداء الجاموس الحلاب وإنتاج الميثان تحت ظروف العبء الحراري. تم استخدام عشرة أمهات من الجاموس المصري الحلاب بمتوسط وزن حي يبلغ ٥٨٥ ± ٣٠ كجم وذلك فى (الموسم الثالث او الرابع من الحلابة)، تم تقسيمها بشكل عشوائي إلى مجموعتين غذائيتين (٥ حيوانات للمجموعة)

المجموعة الأولى الضابطة: وفيها غذيت الحيوانات على العليقة الأساسية للمزرعة بدون أية إضافات، المجموعة الثانية (المعاملة): وفيها غذيت الحيوانات على العليقة الأساسية للمزرعة بالإضافة الى ٥ جرام من البروبيوتيك / للرأس / يوم، (كل واحد جرام من البروبيوتيك Probio-Sacc®يحتوي على خميرة حية *Saccharomyces cerevisiae* *CFU* 10^{10} x 1.5).استمرت التجربة لمدة ٩٠ يومًا ، تم إيواء الحيوانات خلال التجربة في حظائر شبه مفتوحة تحت درجة حرارة٢٣.٣ – ٣٤.٤ درجة مئوية ورطوبة نسبية تتراوح بين ٢١.١ – ٦٩.٣٪، غذيت الحيوانات أثناء فترة الدراسة على عليقة أساسية طبقاً للتوصيات القياسية للـ (٢٠٠١) NRC.

تم قياس متوسط انتاج للبن اليومي، كمية اللبن المعدل ٧٪دهن (FCMY) و نسبة وكمية الدهن، البروتين، الرماد، اللاكتوز، الجوامد الصلبة الكلية (TS) ، الجوامد الصلبة غير الدهنية (SNF) في اللبن في كل مجموعة. تراوحت قيم دليل الحرارة والرطوبة THI من ٧٧.٣١ إلى ٨٠.٤١، مما يشير إلى أن الحيوانات كانت تحت إجهاد حراري متوسط إلى شديد خلال فترة التجربة.

أظهرت النتائج ما يلي: متوسط إنتاج اللبن اليومي وكمية اللبن المعدل ٧٪ دهن ونسبة وكمية الدهن كانت أعلى معنوياً في مجموعة الخميرة مقارنة بالمجموعة الضابطة، كانت نسبة البروتين والرماد واللاكتوز والجوامد الصلبة الكلية والمواد الصلبة غير الدهنية أعلى في مجموعة الخميرة، ولكن بدون معنوية، كان عدد الخلايا الجسدية (SCC) أقل بشكل ملحوظ لكنه غير معنوي في المجموعة المعاملة LY مقارنة بالمجموعة الضابطة، لم يكن لمعاملة الخميرة الحية أي تأثير معنوي على كمية الميثان المنبعث يوميا، ولكنها قللت بشكل غير معنوي من كمية الميثان المنبعث لكل كجم لبن منتج يوميا، مقارنة بالمجموعة الضابطة. يمكن الاستنتاج أن مكملات الخميرة الحية خففت من تأثير الإجهاد الحراري على إنتاج وتكوين اللبن في الجاموس. على الرغم من زيادة إنتاج الميثان في مجموعة الخميرة بسبب زيادة تناول المادة الجافة، إلا أنها خفضت إنتاج الميثان المنبعث لكل كجم لبن منتج.