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Benefits of Supplementing Yeast to Diets on Dairy animals' Performance

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Summary

Intensification of livestock production system using high-grain diets become necessary so that, using feed additives and promoters are very important to enhance feed digestion and efficiency to achieve the desired performance and production from the animals. The supplementation of yeast benefits in ruminants could be achieved by several factors such as (1) induce some modifications in microbial population numbers and species, (2) make some favorable changes in the ruminal volatile fatty acids content, (3) have positive effects on rumen ammonia disappearance, (4) have positive effects on rumen pH, (5) promotes metabolism digestion, (6) increase fiber digestibility and modify microbial protein and amino acids in the large intestine, (7) improving the overall intestinal bacteria balance, (8) reducing digestive problems, (9) reducing the risk of acidosis, (10) reducing the humidity of bedding which results in lower stress levels, (11) improving the appetite of animals which leads to increase the feed intake and enhance feed utilization. The benefits above ultimately will lead to enhancement of milk production, improvement of milk quality, mastitis and somatic cell count reduction, more effective immune system. The impact of yeast on animals' performance depends on different factors including animal breed, physiological stage, yeast strain, supplemented dosage, and feeding strategy. With regarding to the high cost of feed ingredients worldwide, yeast provides a beneficial nutritional strategy, which enhances the feed digestibility and consequently encourages the ruminants' performance in a cost-effective way.

Keywords: Yeast, ruminants, rumen fermentation, digestibility, blood metabolizes, milk yield.

1. Introduction

According to the rapid growth of population in the world, the demand for livestock products increases especially in the developing countries [1]. The expected population growth requires intensif livestock production through using a high-grain diet in order to boost animal production [2-4]. One of the most side effects of using high grain diets to improve performance of livestock is increasing fat deposition and metabolic disorders such as acidosis in ruminants. So, using feed additives may improve rumen health and overcome the troubles of feeding high grain diets [5-7]. Using probiotics in dairy animals' diets could be a solution to modify the gut microbial ecology which could affect the lipid metabolism which in turn can affect the quality of animal products. Probiotics definite mode of action still demarcated, but there are several pathways have been hypothesized. Probiotics have the ability to modify the microbial populations in the rumen by changing its fermentation pattern, also, increasing flow of nutrients to the small intestine and enhancing feed digestibility [8,9]. Moreover, adding probiotics to livestock diets may decrease the cholesterol concentration in the blood serum through directly assimilating cholesterol molecules by microbes [10]. So that, probiotics supplementation could enhance livestock performance beside maintaining the rumen health, enhancing breakdown of fibrous feeds in the rumen by improving the uptake of nutrients, which lead to increasing the yield of livestock products [11]. Yeast is the most common probiotic in ruminant nutrition field which has been approved to affect the restoring gut microbial balance, especially in case of digestive disorders [12]. Yeast widely used in ruminant production field because it can improve feed efficiency and preventing rumen acidosis by its fermentation activities, and its competition with other microbes in rumen [13]. Several authors investigated the efficacy of including yeast into ruminants' diets; but still there are a lot of gaps need to be filled. Many of the published literature on yeast have reported inconsistent results and still its mode of action is not fully understood. With the current global crusade against using antibiotics in livestock diets, the use of yeast to improve rumen fermentation and milk

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production has received great attention. However, the yeast efficacy in improving milk quality and quantity, especially fatty acid profiles and conjugated linoleic acid (CLA) composition, have been neglected.

Supplementing ruminants' diet with yeast also reported to positively modify rumen biohydrogenation pathway towards synthesize more of the beneficial biohydrogenation intermediates (trans-11 and cis-9, trans-11). So that more dietary sources of linoleic acid, linolenic acid, and oleic acid with also the beneficial biohydrogenation intermediates (cis-9, trans-11-CLA, and trans-11) will escape the complete biohydrogenation in rumen and will release into milk and meat [14].

The objective of this review was aimed to over view the effect of supplementing dairy ruminants' diets with yeast on feed intake, digestibility, rumen parameters, blood metabolizes, lactational performance and animals' health.

2. Yeast

2.1. Identification of yeast

Yeasts are eukaryotic microorganisms and are different in structure and functional aspects from bacteria [15]. Yeast is a facultative anaerobe and differs in their shape, reproduction activities, utilized subtracts and yeast very resistant to several antibiotics, such as sulfamides [16]. Yeast resistance cells capability is natural also genetically encoded. Yeast resistance is immutable and cannot be transmitted to another species of microbes. Yeast cell size (5×10 μm) is bigger than bacteria size (0.5×5 μm).

2.2. Differences between active live yeast and yeast culture

Saccharomyces cerevisiae yeast (SCY) experimented extensively in vitro and in vivo [17] to determine its effect in animal models. The active ingredients and the mode of action are the main bases in the classification process of the S. cerevisiae products [18].

Two wide groups of yeast presented in the literature based on cells viability in the product; Active live yeast products, which are dried fermentable living yeasts (contain about 15×10^9 live cells / gm) but yeast culture is produced through fermenting grains within chosen liquid with bakers' yeast after that drying the whole medium [17,18]. Contents of yeast culture (YC) are cell wall (mannan oligosaccharides and β-glucans), vitamins, amino acids, peptides, proteins, nucleotides, lipids, esters, organic acids, alcohols, polyphenols and anti-oxidants [19] all of these contents could enhance the animals' performance and health, when incorporating yeast into its diets.

The bioactive compounds composition in SCY didn't fully characterized [20] so that, the effects of SCY are attributed mostly to the components of the yeast cell wall.

Active live yeast is generally considered as probiotic, at the same time the yeast culture considered as both prebiotic and probiotic. On the other hand, both products are not differing significantly in their effects on the fermentation within the rumen [17].

2.3. Mode of action

Both in vivo and in vitro trials have been conducted to describe the mode of action of SCY in livestock [17]. However, optimistic results might be directly or indirectly related to enhancing the gut environment by SCY by interaction between pathogens and gastrointestinal cells reduction in calves [21] and hence gut health [22]. Various SCY products led to better rumen fermentation [23]. Yeast antagonistic effect on blocking the pathogenicity of bacteria in early development stages generally summarized as following; (1) competition on nutrients, (2) changing pH in the environment, (3) producing high ethanol proportion, (4) producing antimicrobial substrates (Mycocins). Moreover, probiotic organism effectiveness is illustrated as population-specific due to the gastrointestinal microbiota variation, feeding properties, and interaction between host animal and microflora. Yeast cells as a feed supplement are remarked with producing numerous fermentation metabolites, also contain many important enzymes and minerals, which are positively affect the diets nutritive value in ruminants [24,25].

Several researches are needed to determined, which component in active live yeast (ALY) or YC are responsible in health benefits and what is its exact mechanism? The proponents of both ALY and YC usually attributed the yeast products effect to the isolated substrates like mannan-oligosaccharides and β-glucans, which presented in the cell wall of the yeast [26]. The ALY proponents outweigh that yeast cells compete with the pathogens to attachment sites and prevent them attaching to the cells of digestive track wall. In poultry, Spring et al. [27] hypothesized that mannan-oligosaccharides accumulating within the pathogenic bacteria Type-1 fimbriae structures and prevent their colonization in the lumen. These annotations should be studied carefully in calves, because some strains of Enterohemorrhagic Escherichia coli utilizing other mechanisms, specifically type three, which capable to release proteins and cytotoxins to colonize calves' intestines causing diarrhea [28]. However, YC proponents suggested that its metabolites are utilized by gut microorganisms and reducing the numbers of pathogenic microorganisms. Also, the in vitro researches' results stated that the formed metabolites during the YC fermentation process may prevent pathogenic E. coli growth whereas stimulating nonpathogenic E. coli [29]. It is worth mention that the good commensal microbes (fermenting carbohydrates and produce volatile fatty acids (VFA)) utilize Saccharomyces cerevisiae fermentation product (SCFP) metabolites and replace pathogenic microbes in a competitive exclusion.

A few numbers of researchers concentrated on the influence of SCY on stimulating the immune system response of the animal, which can be another illustration of alternative mode of action. Additionally, it is worth mention that SCY able to relief an animal under an environmental or experiencing physiological stress.

3. Effect of including yeast in dairy animals' diets

3.1. Feed intake

A lot of studies demonstrated that YC supplementation may affect the feed intake and the digestive process in the rumen. Dry matter intake (DMI) is considered to be an initial indicator for the rate of fiber digestion; early ruminal activity stimulation can positively affect the feed consumption, which leads to enhance the animal performance [30]. Also, feeding YC to pre-partum cows led to improve DMI [31,32]. Moreover, several studies demonstrated a significantly positive effect of Yea-Sacc®1026 on DMI [33,34]. Allam et al. [35] found that DMI increased significantly by adding yeast (2.5 and 5 g/h/day). Also, El Ashry et al. [36] stated that the DMI increased from 18.26 to 19.86 g/kg LBW by supplementing the diets of male barky lambs with Saccharomyces cerevisiae. However, Saleh et al. [37] concluded an insignificantly increase in DMI from CFM and rice straw when supporting male lambs' diet with Active dry yeast.

The observed positive effect on livestock production is explained better by the feed intake increase rather than the feed digestibility increase. The degradation rate of feed ingredients in rumen stimulated by YC among the first 6 to 8 hrs after meal; at the same time, more dry matter can ingest by the animal to fill its digestive compartment so that this physical regulation could be used to explain the higher feed intake in the treated animals [38]. The outflow rate of digesta from the rumen is another factor influences the physical regulation of intake [39].

Population of total rumen bacteria increases by adding yeast culture to the diet, which cause an increase in the feed intake and feed stuff digestibility, therefore greater feed intake, and greater digestibility, the breeders will put the animal on a higher plane of nutrition [30].

3.2. Nutrients digestibility

The use of live yeast as a supplementation in the animals' diet improved digestibility of OM, CP, and NDF, which may result in increasing the content of digestible energy of the diets, which reflecting in additional milk yield. Desnoyers et al. [40] reported that adding LY or YC as a supplementation to ruminants' diet increased DMI and total-tract OM digestibility. At the end of the experiment the DMI did not affected by the treatments, but digestibility changes and retention of dietary particles in the rumen are unlikely related to intake changes. However, the digestibility of OM along the digestive tract increased in part because of the improvement in digestion of CP and NDF, which related to the increase in the ruminal digestion. the concentration of total short chain fatty acids (SCFA) in ruminal fluid increased linearly by adding LY to the diet, that is a result of the increment in acetate concentration, which is an indicator of the improvement of NDF digestion in the rumen.

The digestibility increment of fiber and OM in the rumen could enhance N recycling, which will reflect on higher yield of microbial protein, which might explain the CP digestion improvement. Furthermore, the increment of fiber and OM digestibility in rumen could reduce the OM amount reached to large intestine, which will reduce the outgoing amount of recycled N to the cecum and colon, so that would be resulted in reduction of fecal N and improving the CP digestion [41]. Another study stated the ruminal digestion increment of NDF and CP digestibility, when supplemented cows' diet with S. cerevisiae [42]. Also, In vitro experiment carried out by Miller-Webster et al., [43] concluded that incorporation of a culture of S. cerevisiae stimulated the microbial fermentation and increased DM and CP digestibility, which could be resulted enhancing the microbial growth [44]. Perdomo et al. [41] stated that the NDF digestion increment combined with the ruminal fluid acetate increment by adding 1 g/d of LY to the diet could be an indicator about the enhancement of digestion of fiber in rumen, which could be resulted from the stability of rumen pH or rumen fibrolytic bacteria increment.

3.3. Ruminal fermentation

3.3.1. Microbial diversity in rumen

Yeast plays an important role in maintaining a balanced rumen environment by associating, with lactate-utilizing bacteria and by supporting the ruminal useful microflora proliferation [45]. Yeast cells have the ability to reduce the accumulation of lactic acid in rumen by stabilizing the rumen pH by suppress the lactate-producing microbes and encourages the proliferation of lactate-utilizing bacteria [23,46]. Megasphaeraelsdenii are common lactate-utilizing bacteria within the rumen of cattle fed highly grain diet [47]. Increment of these bacteria in rumen culture could be a reason for the lactate accumulation reduction [48] which leads to reduce the ruminal acidosis in livestock [49] found that adding yeast enlarged M. elsdenii population in cows' rumen fed a diet containing a high content of grains. These results were in agreement with those obtained by Malekkhahi et al., [51], where yeast supplements were found to increase M. elsdenii proportion within the rumen of cows having sub-acute rumen acidosis (SARA). In different study Ogunade et al. [52] found that, adding yeast as a feed supplement in steers' diet lead to increase carbohydrate degradation bacteria (Ruminococcusalbus, R. champanellensis, R. bromii, and R. obeum), also increased the population of lactate-utilizing bacteria (M. elsdenii, Desulfovibrio vulgaris and Desulfovibriodesulfuricans).

However, Zhu et al. [53] recorded reduction in the lactate-utilizing bacteria proportion (M. elsdenii and Selenomonasruminantium), but numbers of fungi and a number of cellulose degrading bacteria (R. flavefaciens, R. albus, and Fibrobacter succinogenes) increased with including yeast into the diet of dairy cows fed low-quality forage. As well, several studies stated a reduction in the numbers of lactic acid producing bacteria (S. bovis). That could be due to the fermentable sugar availability reduction as a result of using low-quality forage. Mostly, the yeast pronounced by suppresses the lactate producing bacteria proliferation. On the other hand, Fomenky et al. [54] demonstrated total population of Lactobacilli increment in weaned calves' rumen fed on a diet supplemented with yeast. The previous result could be return to the animals' age, where there rumen still not fully formed.

Stimulating the fiber digesting bacteria growth by yeast is well established. Mao et al. [55] investigated yeast effect on rumen microflora and found a significant increment in cellulolytic bacteria population (R. flavefaciens and F. succinogenes). Obtained results could be an indicator on yeast ability to provide nutrients which enhance the cellulolytic bacteria (R. albus, F. succinogenes and R. flavefaciens) growth [47]. Moreover, Chiquette et al. [56] recorded significant reduction in F. succinogenes population in rumen during sub-acute rumen acidosis challenge. Different study carried out by Bach et al. [57], and an increment in Lachnospiracea, Bacteroidales, and Flexilinea population was observed within rumen 14 days before calving, when adding yeast to the diets of pregnant cows. All of these bacteria are known to be a fiber-degrading bacterium for the reason that Flexilinea was known to degrade all of the carbohydrates [58], in addition, either Bacteroidales or Lachnospiraceaespecialise have the ability to degrading cellulose [59] and pectin [60] respectively. So that, these studies concluded that yeast supplementation in ruminants' diet could enhance the growth of several species of fiber digesting bacteria.

Otherwise, Bayat et al. [61] didn't found any influence of live yeast on the numbers of R. flavefaciens, Methanogenic archaea, F. succinogenes, total count, protozoa, and fungi within rumen environment when cows fed diets based on silage. Also, in another trial carried out by Xiao et al. [62], who found that adding yeast culture to Holstein calves' diets enhanced Butyrivibrio percentage and reduced the relative Prevotella proportion in the rumen. These results demonstrated that yeast and its viability have the ability to affect the rumen microbiota composition. Jiang et al. [63] made a comparison between effect of live yeast cells and dead yeast cells on the microflora in the rumen of cows and concluded that the live cells tend to increase the cellulose-digesting bacteria population, but the dead yeast cells didn't affect the cellulolytic bacteria population.

In one of rare studies which investigated yeast efficacy on gene expression, Ogunade et al. [52] recorded increment of the oxidative phosphorylation genes expression indicate that yeast have the ability to scavenge oxygen within rumen environment. Also, Rose [64] mention the yeast efficiency in removing oxygen from the rumen environment; which is extremely essential for maintaining a balanced ecosystem within the rumen because the common rumen microflora are naturally anaerobic [65], So that could answer the question why yeast supporting the growth of numerous species of rumen microbes?

3.3.2. Volatile fatty acids in rumen

Supplementing diets with yeast could modify rumen microbial population, initialize the environment to encourage the fiber digesting bacteria, thus causing alteration in type and proportions of each volatile fatty acid (VFA) produced within rumen. Xiao et al. [62] found that yeast addition to cows' diet increased the butyrate concentration in rumen. On the contrary, Zhu et al. [53] recorded increment in butyrate, propionate, acetate, and total volatile fatty acids concentration subsequent to using yeast additives in lactating cows' diets. Additionally, butyrate concentration increased in calves' rumen [66] moreover a superior propionate proportion within the rumen of matured cattle [42] was observed subsequent to yeast addition. The above result could return to that yeast capable to encourage M. elsdenii development [50,51] which known by degrading lactate into propionate and butyrate [67]. It is worth mention that, the pH most effective than the concentration of lactate on the lactate utilization by M. elsdenii. Accordingly, rumen pH increment will significantly influence the utilization of the lactate by rumen bacteria during acidosis [67]. Previous results may be concluded that rumen pH increment during acidosis will results in increasing the degradation of lactate by M. elsdenii into propionate and butyrate which induce a reduction in the lactate accumulation within the rumen environment. In view of the fact that propionate is major source of glucose in ruminant, also it is the main precursor in gluconeogenesis process [68], it will rapidly be absorbed by the papillae in rumen as a source of energy. Also, butyrate can be another energy source, which can be utilized by rumen papillae and it can contribute in developing the epithelial cells [66]. Moreover, Al Ibrahim et al. [69] experimentally found that yeast supplementation in dairy cows' diet resulted in a higher proportion of ruminal acetate. Correspondingly, another study conducted by Hucko et al. [70] on calves and another on lactating cows [51] summarized significant increment in the acetate concentration, over and above an elevated ratio of acetate to propionate observed, when using yeast as feed addition. The acetate increment recorded in this previous study may related to optimistic effect of yeast on D. desulfuricans and D. vulgaris growth [52] were both capable to switch lactate to acetate [71].

Additionally, Opsi et al. [72] in-vitro experimented the effect of the viability of yeast on volatile fatty acids production and found that the live cells of yeast induced a reduction in the acetate concentration but increased the valerate concentration; on the other hand, inactive yeast tend to increase the concentration of acetate and decrease propionate concentrations.

3.3.3. Ruminal pH

Generally, livestock breeders' resort to use a high grain diets to achieve a rapid growth and high production [73], which may affect the health of gastrointestinal tract of the ruminants [74,75]. In a study carried out by [76] they found that lambs fed on a highly concentrate ration influenced in pH value reduction with inducing a rumen acidosis. There are two types of acidosis could be induced in the rumen (acute and sub-acute). Clinically the acute acidosis recognized as an increment of the lactate concentration in the rumen which induces rumen pH reduction below 5.0; on the other hand, sub-acute ruminal acidosis recognized with a pH ranged from 5.0 to 5.8 for longer phase (more than 3 h / day) [77,78]. It is worth mention that, the main reason for sub-acute acidosis in rumen is the high VFA concentration rather than the lactate accumulation [79]. However, it doesn't mean that no production of lactic acid during sub- acute acidosis, but the micro-organisms had the ability to utilize it faster than its formation [45]. Yeast has the ability to either compete with Lactobacillus and S. bovis for fermentation of the carbohydrates or encourage lactate-utilizing bacteria development, so that the income will be lowering the accumulation of lactate, which leads to a higher pH [13,80,81]. This could be for the reason that yeast has the ability to use the sugar provided in the rumen environment and deny S. bovis from accessing adequate glucose for its growth and metabolic activity. Yeast effects on rumen pH have been numerously studied. For example, in a study on cows fed on diets supplemented with yeast, Dias et al. [42] recorded pH increment in rumen contents. A lot of published studies in meta-analysis, stated that yeast have the ability to increase ruminal pH [40]. On the other hand, in a study on sheep, Chademana and Offer [82] studied effect of yeast supplementation but didn't note any significant rumen pH increment. It is worth mention that, yeast viability influences the fermentation, which sequentially influences the animal reaction towards the supplemented yeast. Additionally, an in-vitro incubation study carried out by Lynch and Martin [17], they found that, adding live yeast cells as a feed supplementation induced an increment in the culture pH, but dead yeast cells decreased the pH. This result was in agreement with those obtained by Opsi et al. [72], where there was no effect on ruminal pH was observed when involving inactivated yeast in the ration formula, while live yeast cells decreased ruminal pH. However, numerous authors [43,45,62] didn't found a significant modification in ruminal pH by adding yeast as feed supplementation. Recorded variations in the efficacy of yeast addition which concluded in previous literature perhaps related to the variations in the basal ration, yeast viability, supplemented dose, forage type which fed to the animals as well as strategy of feeding [83].

So that, rumen fermentations' Changes which attributed to yeast supplementation are: cellulolytic digesting bacteria increase; higher fiber digestion; increasing the utilization of lactic acid by rumen bacteria; propionic acid production increase in the rumen and more rumen pH stability, all of this changes have the ability to increase the animal feed utilization and improve the feed intake [84].

3.3.4. Rumen biohydrogenation modification by yeast

Ruminal biohydrogenation involves linoleic acid transformation to rumenic acid (cis-9, trans-11 CLA) after that hydrogenation processes take a place to produce vaccenic acid (trans-11) lately conversion processes to stearic acid will be inducted [85,86]. Numerous ruminal species of bacteria could be able to induce the linoleic and linolenic acids biohydrogenation. These species could be separated to two groups (group A and groups B) based on the fermentation activities end products. Group A have the ability to convert linoleic and linolenic acids to vaccenic acid (trans-11), while group B known to produce stearic acid (18:0). Some strains of Butyrivibriofibrisolvens are examples for group A rumen bacteria, while group B containing two strains of Fusocillus [85]. The biohydrogenation pathway in the rumen could be influences by yeast to encouraging the growth of the bacteria that affect this process. In addition, yeast can keep the rumen pH at specific level which promote or inhibit several steps in the unsaturated fatty acids biohydrogenation process [87]. Even though the biohydrogenation reduction of the dietary unsaturated fatty acids is valuable, because higher PUFA concentrations could absorbed and stored in livestock products, the biohydrogenation pathway modification to produce elevated amounts of cis-9, trans-11 and trans-11 could be highly beneficial. The yeast ability to increase B. fibrisolvens population in rumen was established in a trial on Holstein calves carried out by Xiao et al. [62]. Ruminal production increment of trans-11 C18:1 mean that larger quantity of cis-9, trans-11 CLA could be store in livestock products as a result of transformation of trans-11 to cis-9, trans-11 CLA in the tissues by D9-desaturase enzyme [88,89] . Additionally, one of the important factors which affecting the ruminal biohydrogenation is the ruminal pH number [58]. It is worth mention that, yeast capable to stimulate the ciliate protozoa growth [90] which capable to enhance milk quality. Ciliate protozoa also have the ability to assimilate cis-9, trans-11 CLA, and trans-11, 18:1. So that, fatty acids which stored in protozoa sooner or later will be absorbed in the small intestine after degradation in the abomasum by acidic digestion [91].

3.4. Blood chemistry

Stella et al. [92] recorded no differences in blood metabolites, glucose, and fatty acid in dairy goats fed on a diet supplemented with yeast. Moreover, in a study on Holstein lactating cows supplemented daily with 30g of S. cerevisiae for 120 days during heat stress period, Bruno et al. [93] demonstrated that concentrations of glucose, blood β-hydroxybutyrate, non-esterified fatty acids, and insulin in plasma were not affected by the S. cerevisiae supplementation. However, urea-N concentrations in plasma decreased by feeding S. cerevisiae, which could be an indicator for the improvement of the protein utilization by using S. cerevisiae as feed supplementation. Regarding to albumin and globulin concentration in blood, Mašek et al. [94] and Galip [95] did not note any increase when sheep fed on diet supplemented with live cells of yeast. Also, Galip [95], Mašek et al. [94], and Křížovă et al. [96] recorded no reduction in serum protein concentration, when S. cerevisiae live cells were added to the ruminant's diet. However, Hristov et al. [97] investigated the effect of adding 56g/head/day of S. cerevisiae yeast culture as feed supplementation on the performance of Holstein dairy cow, and notes that urea and glucose concentrations in the blood plasma weren't affected with the treatment. Also, Datta et al. [98] assigned a depression in plasma cholesterol concentration. In addition, Mašek et al. [94] demonstrated the effect of live yeast culture of S. cerevisiae on blood characteristics of dairy ewes during the period of the machine milking; and recorded an increment of the concentrations of beta-hydroxybutyrate, and non-esterified fatty acids in the treated group when compared with the control group.

In another experiment, fistulated heifers fed diet consisted of 88% meadow hay and 12% concentrate with 10g of live yeast or their metabolites as feed supplementation, Kowalik et al. [99] studied the effect of live cells and metabolites of yeast S. cerevisiae on blood parameters; and They recorded that the total protein, cholesterol and triacylglycerol concentrations significantly decreased in the treated group, when compared with the control group. El-Sherif and Assad [100] concluded that the serum protein reduction was depending on globulin rather than albumin level which lead to the increment of the albumin: globulin ratio. triacylglycerol and total cholesterol level reduction in blood serum of heifers fed diet contain S. cerevisiae live cells could be due to numerous positive changes in fermentation and flora (bacteria and protozoa) in the rumen.

Campanile et al. [101] recorded no effect of the addition of yeast to the diet of buffalo calves on the level of high-density lipoprotein. On the other hand, Pysera and Opałka [102] noted changes in the lipid fractions (very low-density lipoprotein and low-density lipoprotein) in the groups treated with live yeast, when compared with the control group. Conversely, animals fed live yeast cells showed reduction in the high-density lipoprotein level compared to animals in control group or yeast metabolites group. The above results might be due to the changes in the concentration of the short chain fatty acids in rumen mainly propionate, butyrate and valerate and its ability to reduce the triglyceride and cholesterol synthesis in the liver as well as the lipid profile modification in blood. Furthermore, yeast cell wall is a rich source of β-glucans. According to Nicolosi et al. [103], these polysaccharides have the ability to reduce serum concentration of total cholesterol.

3.5. Milk yield and composition

For more than 50 years, additives have been used as feed supplementation in ruminants' diets to enhance milk quantity and quality [104-109]. Numerous studies investigated the efficiency of supplementing dairy animals' diets with yeast [14].

Several experiments were conducted to study the effect of adding yeast into the lactating cows' diets and obtained results detected milk yield enhancement, as well as elevated fat concentration in the produced milk [41,42,110,111,112,113,114] and greater amount of milk protein [112]. The increment of the Milk fat production could be a result of the yeast ability to encourage acetate (precursor of milk fat) synthesis within the rumen [51,69,70].

The improved cellulolytic bacteria proliferation which subsequently resulted after yeast supplementation could also clarify the increment of milk yield and milk fat yield [55], which mean yeast addition could be helpful in inhibition of milk fat depression in dairy cows. Also, Elaref et al. [114] studied effect of adding yeast to ewes' diets and observed elevated yield, enhanced fat, and higher protein content in the produced milk. In contrast, no effects of yeast addition on milk production and fat yield were observed in dairy cows [115-117].

Correspondingly, yeast supplementation to buffalo cows' diet didn't affect the milk yield, milk fat, and milk protein [118]. Due to the animal experiments circumstances the contrasting findings could be arise due to variations in animal lactation stage, product, strain, viability and the dosage of the used yeast product.

Rare studies investigated fatty acid profile in ruminants' milk. In a study on goats, Sulistyowati et al. [119] stated significant increment in the long and medium-chain fatty acids concentration in milk subsequent to yeast addition, in contrast, there was a reduction in the short-chain and unsaturated fatty acids proportion. Furthermore, n6:n3 ratio of fatty acids decreased which could be an indicator on the enhancement of the milk quality. In different study on cows, Yalçın et al., [24] investigated the effect of including yeast into the diets, and they recorded that adding yeast as feed supplement tend to increase linolenic acid (18:3) along with several essential amino acids concentration in milk. The enhancement in n6:n3 ratio and linolenic acid content could be due to the ability of yeast to modulate the unsaturated fatty acids biohydrogenation in the rumen, which may be result in increasing its deposition in milk. In contrary, Bayat et al. [61] found no effects on the fatty acid profile in milk when supplemented dairy cows' diet with 0.5 g/d of live yeast; moreover, they didn't note any effects on yield, fat, protein and lactose content of the produced milk. Correspondingly, Longuski et al. [120] didn't find any effect on fatty acid and CLA composition in produced milk subsequent to adding yeast to dairy cows' diet.

Dairy cows' response to yeast administration is relatively inconsistent where it could be ranging between 2 to 30% higher milk yield. The animals' reaction towards the yeast cultures addition into diets as well could be related to the animals' feed regime as well as the treatment dose and form [121].

Bruno et al. [93] investigated the effect of adding 30g of S. cerevisiae to Holstein lactating cows' diet for 120 days under heat stress. And they recorded 1.2 kg/day constant increment in milk production. Additionally, True protein, solids-not-fat, and lactose were increased by adding yeast as feed supplementation to cows' diet when compared with cows in the control group; but energy corrected milk yield and net energy of milk tend to decrease by feeding a culture of S. cerevisiae for the reason that milk fat concentration was decrease. On the other hand, the milk fat concentration reduction tends to be a result for milk yield increment while the fat production was similar among treatments. The yeast addition could enhance the rumen fermentation which lead to increase fiber and dry matter digestibility which will reflect on increasing absorbed nutrients for milk synthesis. As well, protein production increment could be related to the enhancement of microbial protein synthesis which leads to increase the metabolizable protein supply to the cow's intestine. More and above, Bitencourt et al. [122] stated that yeast supplementation significantly affected each of daily milk yield (29.4 vs 28.5kg), protein yield (0.939 vs 0.908kg), and lactose yield (1.294 vs 1.241kg), although milk fat contents didn't vary; When they studied the effect of supplementing S. cerevisiae as feed additive to mid-lactation Holstein dairy cows fed on corn silage along with citrus pulp as based diets.

Another clarification of increasing true protein in milk could be the modification in the intestinally absorbed amino acids profile; where supplementing dairy cows' diet with S. cerevisiae culture, will enhance the methionine flow into duodenal. Furthermore, Hristov et al. [97] studied the effect of adding 56g S. cerevisiae / day on rumen fermentation, nutrients utilization, ammonia- N production and methane emission in dairy Holstein cows; and they found no differences between the treated group and the control group in milk characteristics (yield, fat corrected milk, energy corrected milk yield, fat, lactose, true protein concentrations and yield, urea-N and milk-N efficiency). Generally, the treatment didn't affect the composition of milk fatty acid (milk fatty acids derived from de novo fatty acid synthesis or preformed fatty acid uptake). Moreover, in a study on rumen fistulated Holstein dairy cows in period between mid to late lactation and suffering from sub-acute rumen acidosis, Chiquette [123] investigated the effect of supplementing diet with S. cerevisiae on rumen fermentation and milk production; the obtained results showed insignificant efficiency on milk fat production, but milk yield tend to increase also, milk true protein observed to be increased, the above results could be due to the ability of supplemented yeast to induce some modification in the rumen fermentation to encourage the supply of glucogenic and aminogenic, but not lipogenic substrates [44,124].

It is worth mention that the form of yeast preparation may differ due to the kind of the cows' production (i.e. milk or meat); so that yeast metabolites (which increase the acetic and decrease propionic and butyric acids levels, which are more valuable for these animals) can be more beneficial than live yeast.

3.5.1. Somatic cell count

Somatic cell count will increase in milk, if any infections or diseases affect the udder. Leucocytes (i.e. somatic cells) increases in the infected udder because it is the animal's first line of defense against the bacteria, which causing health problems. Even so the somatic cell count increment in milk is not desirable because the somatic cell count in milk is one of the most important factors that contribute to judge the quality of milk. Moreover, when there is a fluctuation in ruminal pH, the micoroflora will die within the rumen releasing endotoxins, which will become a reason for inducing hoof and udder inflammation. It is worth mention that yeast has the ability to stabilize the rumen pH, so that the somatic cell count will decrease, which will reflect on enhancing the milk quality. Correspondingly, Chevaux and Fabre [125] stated that the supplementation of LYC to the dairy goats and sheep diets positively reduced the somatic cell count in milk.

4. Immune system

Antibiotics have been used for sub-therapeutic purposes for so long, indicating many benefits in animal production. Antibiotics are generally used to reduce harmful microbes as well as the growth and colonization of non-pathogenic bacteria. This could over stimulate the host immune system, which will withdraw nutrients away from optimal performance. Over and above, the concern associated with the development of a resistant strain through the use of antibiotics has generated strong controversy and objections to sub-therapeutic uses of antibiotics to enhance growth as well as concerns about its transmission from livestock to humans. The influence of yeast cell wall material (i.e. mainly mannan and glucans) on the complement system has been well-known for a long time [126]. Generally, these properties are due to the attendance (in the internal part of yeast cell wall) of glucans. One of the yeast cell wall components is the Mannan oligosaccharide, which can act as a highly affinity bond that offers competitive binding site options for Gram-negative bacteria.

The β-glucan stimulatory effects on both specific and nonspecific immune responses have been established in mammals [127]. The immediate benefits are related to the removal of pathogens from the gastrointestinal tract without attachment and colonization, which may lead to enhancing the antigenic responses and to boost humoral immunity against particular pathogens by introducing attenuating antigens to immune cells. Additionally, these large molecules can encourage definite aspects of the mammalian immune system, particularly the inflammatory response and the reticuloendothelial system. Furthermore, this process may inhibit the pro-inflammatory immune response, which could impair the production performance.

Seguela and Llanes [128] Showed that the existence of live yeast in the digestive tract may have a protective effect against Candida albicans by the peritoneal pathway, indicating an effect on definite components of the nonspecific immune system. Also, Buts et al. [129] established that treating growing rats with S. cerevisiae as oral administration significantly increased IgA and the immunoglobulins secretory component.

5. Viability and stability of yeast products

The probiotics efficacy almost related to the cell viability and metabolic activity [80], thus, the stability within the rumen considered to be an important issue. Yeast modes of action mostly explained by the metabolic activity of live cells within the rumen environment. Even though yeast strains un capable to colonize within the rumen for long period, Once the yeast product ingested, the same number of live cells can persist for 24 to 30 hours in the rumen without any noticeable growth

[130] also Live cells could be able to recover from the feces of treated animals for up to several days after their initial inclusion into the diet.

In the absence of renewal of distribution, the yeast concentration would reduce to undetectable level after 4 to 5 days. For that reason, the most important goal, when selecting a new probiotic strain, would be evaluating its ability to persist for a long time with a significant concentration in the target digestive compartment. S. cerevisiae strain as well have the ability to affect rumen fermentation [131]. It is also notable that molecules in the yeast body (organic acids, peptides and amino acids and vitamins) also contribute the effects of yeast on the rumen microflora.

The protocols of production, storage, and delivery for yeast products have to have the ability to maintain the viability of yeast cells. Several factors such as storage at high temperature or the existence of one or another component like minerals performing as oxidative agent may harm the yeast [132]. The mainly popular and officially method for measuring yeast viability is the colony forming unit plate counting technique. The previous method is depending on counting the cells which have the ability to proliferate in optimum environmental circumstances. The presences of the Microbial cells in the latent stage could make it un capable to confirm colonies on the nutrient media but it could still have additional measurable biochemical activities [133].

6. Conclusion

The advantageous of yeast usage as a feed supplementation into the diets of dairy animals could be concluded that the yeast has positively effect on palatability of the feed, dry matter intake, ruminal fermentation, nutrients digestibility, milk quantity and quality, animals' health, and it has benefits of cost-effective.

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