Comparative Clinical Pathology (2019) 28:669–677
https://doi.org/10.1007/s00580-018-2862-7

REVIEW ARTICLE

Yeast (*Saccharomyces cerevisiae*) and its effect on production indices of livestock and poultry—a review

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Received: 9 June 2018 / Accepted: 1 November 2018 / Published online: 9 November 2018

Abstract

Improved feed efficiency is the current drive of today's livestock enterprise and this may be actualized using feed supplementation. The use of natural growth promoting products in livestock feed is on the increase because of the ban on the use of antibiotics in feed by the European Union (EU). The use of antibiotics in animal feed has been reported to increase antimicrobial resistance and this has made animal nutritionist search for natural alternatives to antibiotics. Yeast, one of such natural alternatives in animal production, has received great attention in the last couple of decades. Research has shown that about 2500 yeast species exist in nature of which *Saccharomyces cerevisiae* is prominent. This paper reviews the current body of knowledge on production and physiological indices of livestock and poultry fed yeast diets. The chemical composition, nutritional analysis, and mechanism of actions of yeast were also discussed.

Keywords Yeast · Composition · Modes of action · Poultry · Livestock · Nutrition

Introduction

Enhanced zootechnical performance in animal placed on in-feed antibiotics has been documented (Gallo and Berg 1995; Kamruzzaman et al. 2005; Gunal et al. 2006). However, because of the biosecurity threats for man and animal health which come from the use of antibiotics, their use in animal diet was banned by EU in 2006. Studies have shown that about 30 types of antibiotics are used in animal production and it is estimated that more than 14% of this is used in sub dose as a growth enhancer (MPC 2001; Jones and Ricke 2003). In a bid to enhance livestock performance, ensure production of healthy animal products, and maintain safer environment, scientists have developed interest in the search for safe alternatives (Fuller 2001). Among all these natural alternatives growth promoters used in animal and poultry production, yeast (*Saccharomyces cerevisiae*) is one the most prominent as shown in the literature. Research data support that yeast modulates the immune system of the host via specific interaction with several immunocompetent cells (Medzhitov and Janeway 2000). Studies have shown that addition of yeast in feed reduce the population of gut pathogens by decreasing the growth of destructive microbes. Yeast aids digestion via enzymatic action and produces lactic acid that makes the gastrointestinal tract to be acidic hence bringing the population of pathogenic microbes down. Yeast is a good source protein (40–45%) and other essential nutrients (Reed and Naodawithana 1999). Increased digestibility and nutrient utilization in animals receiving yeast has been established (Gunal et al. 2006). Yeast contains mannan oligosaccharides (MOS), a natural feed additive in yeast cell wall (YCW) that encourages the growth of beneficial bacteria in the gut and at the same discourages the multiplication of bad types (Yang et al. 2008). The growth-enhancing effect of YCW (0.1% and 0.2%) in broilers has been reported (Santin et al. 2001). Live yeast supplementation at 10 g in heifer diet reduced blood protein, triacylglycerol, and cholesterol levels compared to heifers fed a diet without yeast (Kowalik et al. 2012). This review discussed the chemical/nutritional composition of yeast and its mode of actions as well as the benefits on the productive traits and health status of livestock and poultry.

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The chemical and nutritional composition of yeast

Yeast is rich digestible proteins (42% crude protein), vitamins, and beneficial mineral elements (Haiman and Frank 1994) and may be used for classes of farm animals. Vitamins B1 (thiamin) and B2 (riboflavin) are widely distributed in brewer's yeast (Moore et al. 1994). In addition, yeast is relatively rich in nicotinic acid, vitamin B6, pantothenic acid, biotin, choline magnesium, and zinc, but low in calcium (McDonald et al. 1988). Yeast is also a vital source of amino acids needed by chicken for growth (Haiman and Frank 1994). The nutrient composition of dried yeast was dry matter (95%), ash (10.75%), crude protein (48.7%), ether extract (0.55%), crude fiber (0.5%), soluble carbohydrates (35.55%), phosphorus (5.50%), potassium (2.0%), and chloride (0.03%) (Hamad 1986). Yeast distilling contains 17.25% moisture, 9.2% ether extract, 48.5% protein, 5.3% fiber, 9.65% total ash, 27.35% carbohydrates, and 2.53 kcal/kg metabolisable energy (Samanta and Mondal 1988). Research has shown that yeast protein satisfied the essential amino acid requirements of broilers chicks in excess of the National Research Council (NRC) requirement with the exception of leucine sulfur-containing amino acids. Dried yeast cell has been shown to be low in cysteine, methionine, threonine, and moderate in tryptophan (Samanta and Mondal 1988). The major polysaccharides in the cell wall of yeast are chitin, β-D-glucans, and α-D-mannan and β-D-glucans and α-D-mannan constitute 90% of their weight on dry matter basis. Mannoprotein and its carbohydrate component β-D-mannan enable the cells to recognize and interact with each another and with the environment and determine the immunological specificity of yeast (Ruiz-Herrera 1992; Li et al. 2006). Chitin and β-D-glucans provide support to the YCW and determine its structure and shape. In the gastrointestinal tract (GIT), MOS a polysaccharide contained yeast aid the multiplication of good microbes (Spring et al. 2000).

Mechanisms of action of yeast

Several authors have attributed the positive roles of *S. cerevisiae* on health and productivity of livestock and poultry to

- Stopping the multiplication of pathogens in the GIT hence improving immunity (Kabir et al. 2005; Schneitz 2005; Musa et al. 2009);
- Direct nutritional effect or improvement of digestion (Awad et al. 2006; Apata 2008);
- Promote digestive enzyme activity (Han et al. 1999; Yoon et al. 2004);
- Stimulation of the immune system (Haghighi et al. 2006; Brisbin et al. 2008);
- Lowering gut pH via the production of wide range of organic acids (Chichlowski et al. 2007; Ezema and Ugwu 2014) and;
- Competition with pathogens for adhesion sites on the gut wall, hence stopping the formation of colonies of destructive bacteria (Guillot 2003; Choudhari et al. 2008).

Performance indices of ruminants fed yeast-based diets

Hematology and blood chemistry Similar serum glucose and fatty acids values have been reported in goats at the early stage of lactation (Stella et al. 2007). Comparable blood protein, glucose, cholesterol, and triglycerides of Black Bengal kids fed rice distiller grain with soluble supplemented with yeast have been documented (Pal et al. 2010). These results were in harmony with other authors (Mašek et al. 2008; Galip 2006) who reported that sheep fed YC had similar blood proteins. Hristov et al. (2010) evaluated the effect of yeast-fermented products at 56 g/head/day on nutrient utilization in dairy cows and observed similar levels of serum urea and glucose. In growing Black Bengal goats and finishing steers respectively, Datta et al. (2007) and Engle and Spears (2000) observed decreased blood cholesterol levels in yeast group. Increased β-hydroxybutyrate and non-esterified fatty acids levels have been reported in grazing dairy ewe on yeast supplementation have been documented (Mašek et al. 2008). The observed reduction in the blood cholesterol level of heifers on yeast supplementation may be attributed to improved rumen fermentation and increased population of beneficial micro-organisms in the rumen. Yeast has been reported to enhance the mobilization of fatty tissue in dairy goats (Giger-Reverdin et al. 1996). Quigley et al. (1992) have noticed an increase in rumen butyrate level in dairy calves fed yeast, and this may partly explain the increased blood β-hydroxybutyrate value as reported by Mašek et al. (2008) in grazing dairy sheep. Studies by Kowalik et al. (2012) revealed that live yeast supplementation (10 g) on the diet of heifers containing 88% meadow hay and 12% concentrate significantly reduced blood protein, triacylglycerol, and cholesterol levels compared to heifers fed a diet containing 88% meadow hay and 12% concentrate only. Similarly, El-Sherif and Assad (2001) observed a decline in blood protein levels of sheep during pregnancy and lactation. Similar high-density lipoprotein in buffalo cows fed yeast-based ration has documented (Campanile et al. 2008). Addition of live yeast has been reported by Pysera and Opalka (2001) to modify blood lipids. Cows on yeast-based diets had lower high-density lipoprotein fraction and this could be attributed in part to change in the rumen short-chain fatty acids, especially propionate, butyrate, and valerate acids. Increased concentration of total blood protein and urea in male rams fed yeast-based diets compared with rams on control diet (Galip 2006).

Milk production Studies on the importance of yeast on performance parameters of ruminants have been published (Chevaux and Fabre 2007; Bruno et al. 2009; Table 1). In a study to ascertain the role of yea-Sacc®1026 on milk production in lactating dairy animals, Dawson and Tricarico (2002) conducted a meta-analysis using 22 primary studies and observed a 7.3% increase in milk production in animals fed yeast supplemented diets. The authors also observed increased feed intake and rather than improved digestibility. Similarly, Desnoyers et al. (2009) evaluate the efficacy of 3 yeast types on dairy cows, goats, and ewes. The results revealed that yeast increased milk yield and this agreed with the findings of other investigators (De Ondarza et al. 2010; Ogbuewu et al. 2017) on the efficacy of yeast on milk production. Milk composition is not significantly influenced by yeast supplementation (Ogbuewu et al. 2017). De Ondarza et al. (2010) observe a significant reduction ($p < 0.05$) on milk fat and protein of cow fed live yeast diet. Continuous lactation milk after reaching the peak in cow has been reported (Alonzo et al. 1993). Mašek et al. (2008) fed yeast to lactating dairy ewes and noticed a rise in total milk yield and milk components compared to the group in control. Milk chemical composition parameters measured were not significantly influenced by the dietary yeast supplementation except milk urea-N which differed significantly. Bruno et al. (2009) observed that feeding 30 g of yeast *S. cerevisiae* to heat-stressed Holstein lactating cows for 120 days increased milk yields by 1.2 kg/day. In the same study, the authors observed that true protein, solids-not-fat, and lactose were higher in treated groups relative to the group without yeast. Milk fat, plasma glucose concentration, non-esterified fatty acids, β-hydroxybutyrate, and insulin had comparable values among the groups. Bitencourt et al. (2011) investigated the effect of yeast to mid-lactation Holstein dairy cows fed corn silage citrus pulp diets relative to the control cow and observed 3.16%, 3.41%, and 4.27% increase for daily milk yields, milk protein, and milk lactose respectively, and milk fat concentration was similar among the groups. Enhanced milk production and composition in cows fed yeast has been reported (Zhang et al. 2000). However, Sauvant et al. (2004) showed that inclusion of yeast in cow feed had no effect on milk composition with the exception of milk fat. Similar milk yield and compositions in ruminants fed yeast-based diets has been reported (Ramírez et al. 2007; Cooke et al. 2007).

Fatting The growing benefit of adding yeast in ruminant feed has been reported (Haddad and Goussous 2004; Pal et al. 2010). Issakowicz et al. (2013) reported that addition of live yeast in finishing lambs had 9% carcass yield and reduces plasma lactate concentration more in the groups fed diet without live yeast. External carcass length was also higher in yeast supplemented groups whereas blood glucose concentration. Additionally, Kamal et al. (2013) observed higher live weight, heart girth, and height at withers in native goats fed diet supplemented with *S. cerevisiae* NCDC-49 at 5.6×10^9 cells/head/day than the control. In contrast, Macedo et al. (2006) obtained similar growth performance data in lambs fed concentrate supplemented with 1% YC at free choice. This corroborated the Mikulec et al. (2010) who reported that *S. cerevisiae* supplementation at 0.5 or 1 g/day lambs had similar performance data and cut-out yields. Also, Kawas et al. (2007) observed comparable hot and chilled carcass weights in lightweight lambs fed yeast-based high grain finishing diet. In a similar study in Shami goats and Awassi lambs, Titi et al. (2008) showed increased nutrient digestibility and comparable live weight and growth rate in group fed yeast at 0.012.6 g/kg feed (barley grain and wheat straw based). The reasons for the disparity observed in different yeast supplementation may be attributed in part to feeding strategy, type of diet and forage fed, and quantity of yeast added (Mikulec et al. 2010).

Table 1 Practical conclusions and recommendations on the use of yeast in ruminant production

Ref.	Practical conclusion and recommendations
1.	Addition of 30 g of yeast *S. cerevisiae* in the diets of heat-stressed Holstein lactating cows for 120 days increased milk yields by 1.2 kg/day.
2.	Dietary yeast supplementation at 2% in the diet of mid-lactation Holstein dairy cows fed corn silage citrus pulp-based diets increased daily milk yield, milk protein and milk lactose by 3.16%, 3.41%, and 4.27% respectively compared with the control.
3.	Addition of yeast culture at 0.012.6 g/kg feed (barley grain and wheat straw based) increased nutrient digestibility in sheep
4.	Yeast supplementation at 10 g on heifers fed a diet containing 88% meadow hay and 12% concentrate decreased blood protein, triacylglycerol and cholesterol content

1—Bruno et al. (2009); 2—Bitencourt et al. (2011); 3—Titi et al. (2008); 4—Kowalik et al. (2012)

Importance of yeast on pig production

Antibiotics are added in weaner pig diet to stop postweaning diarrhea, low feed intake, and body weight loss (Mikkelsen and Jensen 2004) and their ban demand new alternative growth promoters. Studies that compared productive indices of pigs on yeast diets in comparison with antimicrobial growth promoters are variable with some authors reporting positive results (Van Heugten et al. 2003; Liu et al. 2018) (Table 2), whereas others have not (Jurgens 1995; Kornegay et al. 1995). The improved immune status in weaner pigs that received yeast-based feed corroborated with Van Heugten et al. (2003) who reported that enhance the immune system and maintain the population of beneficial microbes in the gut. van der Peet-Schwering et al. (2007) have comparable hematological indices of pigs fed YC with the exception of platelets, CD4 and CD8 lymphocytes. This agreed with Jiang et al. (2015) who reported increased CD4+/CD8+ ratio and T-lymphocytes in broilers fed yeast. Addition of YC (0.5%) enhances production traits of nursery pigs (Shen et al. 2009) and this finding supports Gao et al. (2008) that noticed that addition of yeast improves daily gain in pigs. Comparable in the same study, Shen et al. (2009) observed no effect of YC on histology of small intestine at the growing pigs but the reverse was the case for nursery pigs. Similar results were reported in finely ground yeast cells (Bontempo et al. 2005). It was observed that YC supplementation at 12–15 g/d during gestation and lactation increased ($p < 0.01$) litter birth weight gain by 6.9% in comparison to the control (Kim et al. 2008). The observed increase in litter and pig weight gains in YC may have been contributed several factors such as increased sow milk production and milk quality (Ogbuewu et al. 2017), and improved nutrient digestibility (Ezema 2012). MTB 100®, a yeast commercial type preparation increase the reproductive rate on sows fed mycotoxins infected diets (Guerrero and Banegas 2001; Frio et al. 2006) and reduce the negative impact of mycotoxins in reproductive rate of in pig (Díaz-Llano and Smith 2006). Jiang et al. (2015) showed that addition of 0.3% each of live and superfine yeast increased ($p < 0.05$) serum concentrations of growth hormones, triiodothyronine, tetraiodothyronine, and insulin growth factor (IGF-1) and reduced serum urea nitrogen in weaner pigs. This trial suggests that dietary inclusion with LY and SFY may increase the rate of protein synthesis and reduce the rate of amino acid catabolism in weaned piglets.

Performance indices of poultry fed yeast-based diets

Broiler production Yeast is used extensively in animal production to improve performance as well as for brewing and baking purposes. The practice of adding yeast in broiler feed to boast growth has been documented (Kabir et al. 2004; Ezema 2007) as presented in Table 3. Better weight gain (WG) has been obtained by Swamy and Upendra (2013) in broilers fed 0.1% yeast. These results supported the findings other researchers (Kalavathy et al. 2003; Kamruzzaman et al. 2005) that reported better WG in broilers fed yeast-based diets. In broilers, yeast is found to reduce *E. coli* infection and pathogens in the GIT (Huang et al. 2004; Saadia and Nagla 2010). *S. cerevisiae* has been reported to boost immunity, blood globulin (Abaza et al. 2008), and white blood cells (Abdollahi et al. 2002). Kabir et al. (2004) studied the influence of yeast on the health status of broilers and observed better antibody level in treated chickens. Similarly, Haghighi et al. (2006) showed that dietary *Saccharomyces cerevisiae* improve blood and gut natural antibodies in chickens. Ezema (2012) reported an increased in aspect of differential white blood cell count in broilers fed yeast, while Kabir et al. (2005) reported improved meat quality in broilers fed yeast. It was observed (Yusrizal 2003; Zhang et al. 2005; Ezema 2007) that yeast application in broiler diets enhances meat quality. Better protein and fiber digestibility was observed in meat typed

Table 2 Practical conclusions and recommendations in the use of yeast in pigs

Ref	Practical conclusion and recommendations
1.	Inclusion of mixture of yeast culture (0.125%) + cell wall product (0.2%) for 35 days resulted in an increased body weight in 27-day-old weanling pigs.
2.	Addition of yeast at 5 g/kg to weaning pig feed significantly improved daily weight gain by 21% when compared with the control piglets.
3.	The inclusion of 2 g yeast cell wall products improves the performance of pigs that consumed a mixture of 4.8 mg/kg deoxynivalenol and 0.3 mg/kg zearalenone.
4.	Feeding of different yeast form (3.0 g/kg live yeast, 2.66 g/kg heat-killed whole yeast and 3.0 g/kg superfine yeast powder) improved feed conversion ratio and immune responses, and enhanced gut development in early-weaned piglets
5.	Dietary yeast inclusion of 2.0 kg/d of yeast culture in sow diet increased litter size by 6.9% when compared with the sows on control treatment.

1—van der Peet-Schwering et al. (2007); 2—Shen et al. (2009); 3—Weaver et al. (2014): 4—Jiang et al. (2015); 5—Kim et al. (2008)

Table 3 Practical conclusions and recommendations in the use of yeast in broiler chickens

Ref.	Practical conclusion and recommendations
1.	Addition of yeast at 0.8 g/kg feed gave optimum broiler production
2.	Dietary inclusion of baker's yeast at 2% for 21 days gave the best weight gain and feed conversion ratio and reduced ($p < 0.05$) the serum glycerides and cholesterol.
3.	Incorporation of yeast 1.5% in broiler diet reduce ($p < 0.05$) plasma cholesterol and triglycerides.
4.	Addition of 0.2% yeast in broiler chicken diet improves feed efficiency and average weight gain.
5.	Incorporation of 1.0% baker's yeast in broiler chicken diet for 8 weeks improves feed conversion ratio and weight gain.
6.	Dietary inclusion of dry yeast at 0.5% in Arbor acre broilers for 42 days improved weight gain by 4.5% with 4.39% less feed intake as compared to the control. Also, birds on 0.5% dry yeast had the best feed efficiency and the highest total serum proteins and lower serum total cholesterol.
7.	Replacement of soybean meal with 10.5 g yeast single cell protein per kilogram ration in Hubbard broilers for 35 days gave the best weight gain and feed conversion ratio
8.	Dietary yeast supplementation at 0.5% via drinking water in Anak broiler diet for 8 weeks improved weight gain and feed conversion ratio.
9.	Dietary yeast supplementation at 0.5% via drinking water in Anak broiler chicks' diet for 7 weeks improved weight gain, feed conversion ratio, carcass, and organ weight.
10.	Addition of 0.2% yeast in Marshall broiler chicken diet for 42 days improved feed conversion ratio and aspect of blood chemistry and increased weight gain.
11.	Dietary yeast supplementation at 1.0% in Hubbard broiler diet for 6 weeks improved relative weights of breast and thigh and weight gain.

1—Ezema (2007); 2—Shareef and Al-Dabbagh (2009); 3—Paryad and Mahmoudi (2008); 4—Shankar et al. 2017): 5—Buba et al. (2016); 6—Manal (2012); 7—Ihsanuddin and Khan (2014); 8—Onwurah et al. (2014); 9—Onwurah and Okejim (2014); 10—Aluwong et al. (2012); Ahmed et al. (2015)

chickens fed a diet containing yeast probiotic (Ezema 2012). The observed increase in protein and fiber digestion may be linked to yeast ability to increase the beneficial microbes in the GIT. Plavnik and Scott (1980) observed that addition of 2.5% or 5.0% brewer's yeast in broiler diet reduce the incidence of leg weakness in broiler chickens.

Egg production Yeast has a high potential as feed additive for poultry (Table 4) and interest in yeast could be due to its probiotic effect (Fuller 2001; Kabir et al. 2004), immune-stimulating ability (Toms and Powrie 2001; Cotter et al. 2002), and high nutrient value (Moore et al. 1994). Yeast incorporation at 0.02–0.04% improved nutrient utilization on

Table 4 Practical conclusions and recommendations in the use of yeast in laying birds

Ref	Practical conclusion and recommendations
1.	Addition of 0.4% or 0.8% yeast culture in layer diets increased egg production and quality (albumen, yolk and eggshell thickness).
2.	Yeast supplementation at 3 g/kg in brown laying hen diet increased ($p < 0.05$) shell thickness, egg yolk and reduced ($p < 0.05$) egg albumen.
3.	Yeast inclusion at 0.4 g yeast per kg diet in laying hens reduced egg weight
4.	Incorporation of yeast culture at 0.8% in layer diet increased eggshell thickness.
5.	4 g yeast autolysate per kg diet increased egg production and weight, and reduce yolk cholesterol
6.	Dietary addition of 1% of inactivated yeast for 14 days in 22 weeks old brown layers increased percentage hen-day production and improved feed conversion ratio (kg feed/kg egg).
7.	Dietary yeast supplementation at 1.5 g/kg feed increase albumen and shell thickness, and improves egg weight and feed efficiency in Vanaraja layers.
8.	Dietary yeast culture supplementation at 0.3% for local (Balad) and 0.2% for exotic (white leghorn) gave the best performance.
9.	Addition of yeast cell wall at 1 or 2 g per kg diet for 26 weeks in brown layers aged 29 weeks decreased egg yolk cholesterol.

1—Hassanein and Soliman (2010); 2—Sanaa (2013); 3—Dizaji and Pirmohammadi (2009); 4—Nursoy et al. (2004); 5—Yalcın et al. (2010); 6—Pinar et al. (2013); 7—Swain et al. (2011); 8—Najib (1996); 9—Yalçin et al. (2014)

lay birds (Dizaji and Pirmohammadi 2009; Hassanein and Soliman 2010). This finding corroborated the results of on the ability of yeast culture to enhance feed conversion ratio (FCR) in laying chickens (Yousefi and Karkoodi 2007; Yalcın et al. 2010). Yalcin et al. (2008a) reported better weight gain of laying hens in oil seed meal containing 0.2% YC compared with the control. This corroborated Sehu et al. (1997) who noticed similar feed intake (FI) and FCR in laying quails fed 15% inactivated brewer's yeast. However, depressed FI has been reported in quails at 0.2% yeast supplementation (Liu et al. 2002) and 3–6 g/kg (Sanaa 2013). Incorporation of yeast in layer feed improved egg and yolk weight (Swain et al. 2011) and shell weight and thickness and reduced yolk cholesterol (Yousefi and Karkoodi 2007; Yalcin et al. 2008a; Swain et al. 2011). It was noticed that inclusion of up to 0.4% yeast autolysate in 22-week-old chickens increased laying performance and also decrease yolk cholesterol content (Yalcın et al. 2010) whereas addition of 0.3% yeast improved shell quality and reduced egg white (Sanaa 2013). The inclusion of 0.8% yeast in layer diet increased the eggshell thickness (Nursoy et al. 2004). The improvement in eggshell could be due to increased nutrient digestibility (Ezema 2012) leading to increased uptake of calcium from the gut. Yeast supplementation at 0.3–0.6% decreased laying rate in laying hens aged 26 weeks (Sanaa 2013). Chickens fed 0.04% have been reported to lay smaller eggs when compared with chickens in the control groups (Dizaji and Pirmohammadi 2009).

Hematology and blood chemistry It was observed that addition of 0.2% YC in layers fed diets containing oilseed meals had no deleterious effects on laying rates and serum biochemistry and hematological characteristics (Yalcin et al. 2008b). Other researchers have reported that dried yeast (*Saccharomyces cerevisiae*) can be included at 6 g per kilogram diet in layers without deleterious effect on some hematological parameters (Sanaa 2013; Yalçin et al. 2014). In similar studies, Wakwak et al. (2003) and Maziar et al. (2007) noticed the non-significant effect of yeast supplementation on serum proteins and serum cholesterol, respectively. Addition 2 g of yeast culture per kilogram feed in laying hens fed either soybean meal or sunflower meal had no negative effect on some aspect of serum liver enzymes (Yalcin et al. 2008a). This observation corroborated Hewida et al. (2011), who noticed that yeast supports the formation of blood proteins and creatinine. Contrary to the observation of Maziar et al. (2007) on the non-significant effect of yeast on serum cholesterol, other researchers have shown that dietary yeast supplementation reduce ($p < 0.05$) serum cholesterol (Mahdavi et al. 2005; Yalcin et al. 2008a, 2010, 2014; Hassanein and Soliman 2010) and serum triglycerides (Yalçin et al. 2014). A similar study in quails, Ghally and Abd El-Latif (2007) observed improved blood constituents in groups fed diets with 1 and 2% yeast culture.

Conclusion

Based on the body of knowledge of the effect of yeast (*S. cerevisiae*) and yeast products on health status, growth and productivity of ruminants, pig, and chicken, it can be inferred that inclusion yeast in animal diets improved blood and productive traits in the majority of the papers reviewed. However, the inconsistent in most of the results as reported by these authors could be as a result of the factors: diet type, yeast strain used, supplementation rate, and livestock species. The beneficial effect of yeast supplement on physiological well-being of animals may be achieved via any of this mechanism or their combinations: (1) by reducing the population of pathogenic microbes by competing for available sites, (2) by direct nutritional effect or their ability to improve feed intake and nutrient uptake from the gut, (3) by lowering pH of the gut through the production of wide range organic acids, and (4) by decreasing bacteria enzyme activity and ammonia production.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

Ethical approval This paper does not contain any studies with animals or human performed directly by any of the authors.

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