USAGE OF ANTIOXIDANTS SUPPLEMENTATION IN BULL SEMEN, A WAY TO IMPROVE REPRODUCTIVE PERFORMANCES OF CATTLE

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Abstract

Improving livestock reproductive performances is a high priority of worldwide breeders. The knowledge on cows accurate estrous detection associated with a good semen bull quality and artificial insemination appropriate timing, contribute in improving animal production yield. According to some studies, it is possible to achieve good quality semen from bulls by applying methods such the selection of bull presenting good conformation and health, followed by the collection and analysis of their semen, to be insured that this contains enough well fitted spermatozoids. For better success of artificial insemination, it is important to have a good mastery of the technique. The semen should also be protected against any agent of destruction and degeneration of spermatozoa, such as oxidizing processes. The present review gathers some technics of collecting and analyzing semen bull as well as some types of semen extender supplementation with antioxidant substances.

Key words: bull semen, oxidative protection, cow, artificial insemination

INTRODUCTION

Agriculture, animal husbandry and fishing are priority sectors because of their contribution to the production of the food necessary to cover the needs of the population. These sectors also contribute to job creation and currency production [35], [17]. In most Sub-Saharan countries such as Cameroon, agricultural and livestock practices are limited to traditional systems resulting in low production yields, which are very insufficient to meet the population's demand. According to the World Health Organization (WHO), hunger and inadequate nutrition contribute to the early mortality of mothers, infants and young children leading to a delay in physical and cerebral development of young people [43]. In 2008, an estimated 1.29 billion people lived with less than $1.25 a day, representing 22% of the developing world's population [45]. Of these people, about 925 million are undernourished, 98% of whom live in developing countries [18]. In such a context, the WHO (2017) stresses that malnutrition is a real threat to human health.

In Cameroon, many families suffer from malnutrition despite the country's agricultural potential. According to a study conducted by the FAO (2004), the cattle industry is experiencing serious problems, including the sharp increase in cattle from the CAR and Sudan with significant health risks, the rise in consumer prices, the resurgence of fraudulent supply channels. Similarly, the minimum quantities of milk and meat to be consumed per capita per year should be 22 kg and 42 kg respectively. However, these values remain very low in Cameroon (6 kg and 13.3 kg respectively) forcing the country to go for

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import. Yet, milk and meat are major sources of nutrients useful for human health [34]. Faced with this situation, profound changes in agricultural markets offer promising new opportunities for smallholder farmers to boost their productivity. By opting for genetic progress in animal production through new technologies such as artificial insemination, embryo transfer, etc., the livestock sector will experience a considerable increase in the production yields of cattle, swine, goat and sheep species.

Cameroon is known as the economic leader of the Central African sub region. The country has several animal production basins with cattle breeding practiced in the Adamaoua, North-West, West, Far North and North regions. Sheep and goat rearing is practiced in the North, Far North, and Adamaoua regions, followed by Belly sheep in the center, South, and East. Pig farming is practiced in the West, North and South-West, Littoral, Center, South, Adamaoua and Far North regions. In these different production basins, there are more than 6000000 head of cattle, more than 8690000 head of sheep and goats and more than 1700000 head of pigs [13]. In addition, agro-ecological zones offer natural conditions conducive to the feeding and development of livestock. Despite these assets, livestock production yields remain very low forcing the State of Cameroon to resort to imports leading to foreign exchange losses with negative impacts on the national economy [30]. Livestock farming as practiced in the country remains in its primary state and will not ensure food self-sufficiency in the future. For example, the cattle found there are local breeds (Red Fulani, Gudali...) that weigh an average of 500-800 kg and produce about 1-3 L of milk per day. These low productions observed in local breeds are mainly due to the poor genetic potential. To address the problem, it is important to encourage crossbreeding of local and exotic species. At the Agricultural Research Institute for Development in Cameroon, there are two exotic Holstein bulls on which the seed collections are made. However, conservation of semen collected remains very difficult because fresh semen is lost quickly. Amongst preservation techniques that do exist, cryopreservation could be very helpful because cryopreserved semen can be used after a long period of time for several years.

LITERATURE SURVEY

Importance of cryopreservation of animal semen

The application of cryopreservation and artificial insemination technology has contributed to the advancement of animal reproduction. However, a significant proportion of semen undergoes alterations and loses its fertility during cryopreservation, making frozen-thawed semen impractical for routine use. Cryopreservation is known to reduce sperm lifespan and fertility. The variation in cryo-survival of semen from different bulls and even from a single bull is common in artificial insemination (AI) centers.

Deleterious action of free radicals on frozen semen

Semen storage is associated with cold shock and atmospheric oxygen [3], [6], [29] which has led to a higher production of reactive oxygen species (ROS) and an imbalance between free radicals and the antioxidant system of the semen storage. Oxygen radicals at physiological concentrations have a positive effect on intracellular signaling involved in cell proliferation, differentiation and migration processes, as well as in spermatozoa capacitation, hyperactivation and spermatozoa-oocyte fusion [1], [14]. However, an excessive production of ROS might have a cytotoxic effect through the production of free radicals that affect the functional characteristics of spermatozoa, such as reduced spermatozoa motility [39], inactivation of glycolytic enzymes and damaging the acrosomal membranes [4] which would render spermatozoa unable to fertilize an oocyte [21]. For this reason, it will be important to add an antioxidant supplement to sperm storage to maintain sperm viability and fertilizing potential.

Effect of antioxidant supplementation on sperm viability and fertilizing potential

Antioxidants, in general, are compounds that impede and suppress the formation of ROS and lipid peroxidation. Among the well-known biological antioxidants, GSH, glutathione peroxidase, catalase, and superoxide dismutase (SOD) have significant roles as suppressors or trapping of free radicals. Hence, the application of ROS scavengers is likely to improve sperm function [22], [42], [38]. Many plants including fruits and vegetables are recognized as sources of natural antioxidants that can protect against oxidative stress and thus play an important role in the chemoprevention of diseases that have their etiology and pathophysiology in reactive oxygen species [16], [28] [7]. These positive effects are believed to be attributable to the antioxidants particularly the carotenoids, flavonoids, lycopene, phenolics and β-carotene. A study was carried out to investigate the effect of substituting egg yolk in egg-yolk-citrate (EYC) extenders with extracts from Tomato and Pawpaw fruits as well as Coconut milk and Raffia palm sap on the motility of bull spermatozoa [9].

Antioxidant properties of mushrooms

Mushrooms which have long been appreciated for their flavor and texture are now recognized as a nutritious food as well as an important source of biologically active compounds of medicinal value [10]. Mushrooms accumulate a variety of secondary metabolites, including phenolic compounds, polyketides, terpenes and steroids. Also, a mushroom phenolic compound has been found to be an excellent antioxidant and synergist that is not mutagenic [19]. Studies have shown that tropical mushrooms are highly rich in proteins, minerals, vitamins, crude fiber and carbohydrate with low fat and oil content. The protein content of mushrooms has been reported to be twice that of vegetables and four times that of oranges and significantly higher than that of wheat [31], [8]. The high level of vitamins in mushrooms particularly vitamin C and D has been reported as responsible for its antioxidant activity [8], [22]. Mushrooms contain also some appreciable quantities of crude fibers, although little information exist their Total Dietary Fibre (TDF). The crude fiber content values reported from many studies suggest that mushrooms are potential sources of dietary fiber [8]. Mushrooms generally contain low fat and oil content [8]. Because of the low fat and oil content, they are recommended as good source of food supplement for patients with heart problems or at risk with lipid induced disorders.

Antioxidant properties of *Adansonia digitata*

Baobab tree (*Adansonia Digitata L*) is found widely throughout Africa and known locally in African countries as the “tree of life” due to its ability to sustain life owing to its water holding capacity, as well as its many traditional medicinal and nutritional uses [4]. The baobab administration at different concentrations could significantly improve the activity of antioxidant enzymes (SOD, CAT and GSHPx) and the levels of non-enzymatic antioxidants in rats fed high fat diet. According to [2], increasing the concentration of baobab would increase the antioxidant activity. Baobab is rich in natural antioxidant such as total phenols, total flavonoids and Vitamin C in particular. The phenolic groups in polyphenols can accept an electron to form relatively stable phenoxyl radicals, thereby disrupting chain oxidation reactions in cellular components. Polyphenols are potent inhibitors of LDL oxidation.

Antioxidant properties of Curcumin

Curcumin is a bright yellow compound found in turmeric, which is derived from the rhizomes of the plant Curcuma longa, a perennial herb of the family Zingiberaceae [5]. Curcumin is a lipophilic polyphenol that is insoluble in water [36]. Curcumin has been shown to trap free radicals [39]. Under *in vitro* conditions, curcumin significantly inhibited the generation of ROS, such as superoxide anions and H_2O_2, and nitrite radical generation by activated macrophages, which plays an important role in inflammation [28]. Curcumin lowers the

production of ROS in vivo [23]. The antioxidant mechanism of curcumin is attributed to its unique conjugated structure, which includes 2 methoxylated phenols and an enol form of diketone; the structure of curcumin shows typical radical-trapping ability as a chain-breaking antioxidant [25]. Supplementation of fresh bull semen with curcumin significantly increased the sperm content of GSH after thawing [11]. Administration of curcumin to male rodents challenged by a reproductive toxicant appeared to have a protective effect toward testicular function and fertility [37].

Antioxidant properties of honey Bee compounds/*Propolis propolis*

Honey bee compounds have been used as a folk medicine from ancient times. It is an adhesive, dark yellow to brown balsam. Propolis is the generic name for the resinous substance collected by honeybees from various plant sources [12]. It has a wide range of biological activities including antibacterial, antiviral, anti-inflammatory, and anti-oxidative [29]. Activities of propolis are based on its rich contents of flavonoids, phenolic acids, and terpenoids. In fact, propolis could contain more than 300 components, including phenolic aldehydes, polyphenols, sesquiterpene quinines, coumarins, steroids, amino acids, and inorganic compounds [41]. Among them, phenolic compounds such as flavonoids are thought to be primarily responsible for the biological activity of propolis. Current knowledge indicates that propolis protects the reproductive system from toxicity. Flavonoids and phenolic compounds particularly have an antioxidant activity and show protective effects against aluminum chloride, which caused testicular dysfunction, deterioration in semen quality, and lower testosterone concentrations [46]. Studies in various mammals reported that propolis significantly increased testosterone, body weight, relative weight of the testis, relative weight of the epididymis, percentage of motile and morphologically normal spermatozoa, and content of seminal plasma enzymes, and it decreased concentrations of free radicals and lactate dehydrogenase in rabbits [47]. Propolis decreased the percentages of dead and abnormal spermatozoa and increased testosterone in rats [20]. Propolis was also reported to inhibit the generation of superoxide anions and to reverse the consumption of GSH, which is synthesized in the liver and has a free radical–trapping activity [14].

CONLCUSIONS

Recent studies state that plants contain large amounts of antioxidant substances known as ROS with trapping potentials. Since ROS are largely involved in the process of sperm deterioration in animal semen, a substitution of plant extracts in the stents used in the seed cryopreservation process could promote better seed quality. However, extensive studies need to be done to evaluate the viability of sperm after cryopreservation with plant extract expanders.

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