Original Research Article

Perturbation of Sex Hormones by Potassium Bromate and Preventive Effect of African Locust Bean (*Parkia biglobosa*) Seed

ABSTRACT

Background: African locust bean is used for medicinal purposes in African countriesfor the treatment of various diseases. However, no study has reported its ameliorative effect on sex hormones perturbations. This study, therefore, sought to investigate its preventive effect against potassium bromate-induced perturbation of sex hormones

Methodology: African locust beanwas extracted with soxhlet extractor with ethanol as the solvent. Twenty-four adult male Wistar rats were acclimatized under laboratory conditions and were randomly grouped into A, B, C and D. Group A was given distilled water orally. Animals in groups B, C and D were administered 100 mg/kg body weight of potassium bromate, but groups C and D were also treated with 100 and 200 mg/kg body weight of African locust bean respectively. Both potassium bromate and *African locust bean* were freshly prepared on daily basis and administered to rats by oral gavage. After 28 days of treatment, the animals were sacrificed under mild diethyl ether anaesthetization 24 hours after cessation of last treatment and blood was collected through cardiac puncture.

Results: Analyses showed that $KBrO_3$ significantly reduced the levels of luteinizing hormone (LH), follicle stimulating hormone (FSH) and testosterone but elevated the levels of prolactin and estradiol when compared with those in the control group. However, groups treated with 100 and 200 mg/kg body weight of African locust bean in conjunction with KBrO3 resisted these perturbations.

Conclusion: In this study potassium bromate increased the levels of estradiol which has been known to inhibit sex hormones. This effect of estradiol on sex hormones; LH, FSH and testosterone is further evidenced by the results of this study. The potential benefit of the African locust bean in the amelioration of perturbation of sex hormones is brought to the fore by the findings of this research.

Keywords: African locust bean; male sex hormones; potassium bromate; preventive effect

1. INTRODUCTION

The substance potassium bromate ($KBrO_3$), which is present in drinking water, food additives, and hair products, damages the vestibuloocular reflex system and causes sensorineural hearing loss [1, 2]. The barley, cosmetics, and water purification industries all employ $KBrO_3$. Due to an increase in $ONOO^-$ and 8-hydroxydeoxyguanosine levels in DNA brought on by oxidative stress, $KBrO_3$ causes chromosomal aberration and promotes cancer [3].

Follicle-stimulating hormone (FSH), luteinizing hormone (LH), and testosterone are the main hormones that affect how the male reproductive system works. The pituitary gland produces FSH and LH. It is situated at the base of the brain and controls a variety of bodily processes. For the

generation of sperm, FSH is required (spermatogenesis). To continue the process of spermatogenesis, testosterone must be produced, which LH stimulates. In response to gonadotropin releasing hormone (GnRH) from the hypothalamus, the anterior pituitary produces follicle-stimulating hormone (FSH) [4]. FSH plays a role in sexual development and reproduction in both males and females. FSH is an alpha and beta sub-united glycoprotein dimer [5]. FSH release is promoted by GnRH. The anterior pituitary's gonadotropic cells create GnRH, which is then released into the hypophyseal portal circulation to act on G protein-coupled receptors. FSH and LH are produced by those gonadotropic cells and released into the peripheral circulation. Pulsatile GnRH release occurs, with low pulse frequencies stimulating more FSH and high pulse frequencies stimulating more LH [4]. The main male hormone, testosterone, is in charge of controlling sex differentiation, generating male sex traits, spermatogenesis, and fertility [6]. It is in charge of initial sexual development, which entails spermatogenesis, testicular descent, growth of the penis and testes, and an increase in libido [7]. Additionally, testosterone controls secondary male traits, which are what give men their masculinity. Male hair patterns, vocal changes, voice deepening, anabolic effects such as growth spurts in puberty (testosterone increases tissue growth at the epiphyseal plate early on and eventually results in plate closure later in puberty), and skeletal muscle growth are some of these secondary sex characteristics (testosterone stimulates protein synthesis). Males have a higher hematocrit than females due to testosterone's stimulation of erythropoiesis [8,9].

A perennial deciduous tree in the Fabaceae family, *Parkia Biglobosa* is often referred to as the African locust bean [10]. It grows in a variety of African habitats and is mostly cultivated for its pods, which are harvested for their rich seeds and tasty pulp. The crushing and fermentation of these seeds is a significant economic activity where the tree is grown [11]. The locust bean tree's many parts are utilized as medicines [12,13]. It has been utilized to treat a range of illnesses in Nigeria and other rural West African cultures, including malaria, diabetes mellitus, infections, hypertension, and inflammatory disease [14,15]. No research has reported its ameliorative effect on sex hormones perturbations. This study, therefore, sought to investigate its preventive effect against potassium bromate-induced perturbation of sex hormones

2.MATERIALS AND METHODS

2.2 Collection and Extraction of African Locust Bean Seed

After being purchased from a local market in Ibadan, Nigeria, a botanist identified the African locust bean seeds. They were turned into powder using a mechanical blender after being sun-dried. The extraction was performed using a soxhlet device and ethanol as the solvent, following the procedures outlined byAiraodion et al. [16,17]. The ethanol was evaporated in a rotary evaporator at 35 ^{o}C with a yield of 2.55 g and a percentage yield of 10.20 percent. The extract was kept in the fridge until it was required.

2.3 Animal Treatment

The experiment involved twenty-four (24) mature male Wistar rats (*Rattus norvegicus*) weighing between 140 and 160g. Prior to the study, they were acclimated in a lab setting for seven (7) days. The rats were kept in cages made of wire mesh, and they had unrestricted access to commercial rat food and water. The animals were housed at regular temperatures and humidity levels with 12-hour light and dark cycles. The Declaration of Helsinki and the regulations set by the Committee for the Purpose of Control and Supervision of Experiments on Animals were followed in conducting this investigation. Additionally, animal experimentation was conducted in accordance with NIH guidelines [18]. They were divided into groups A, B, C, and D at random. Animals in group A received oral distilled water. Animals in groups B, C, and D got 100 mg/kg

body weight of potassium bromate, whereas groups C and D also received 100 and 200 mg/kg body weight of African locust bean, respectively. Rats received oral gavages of fresh potassium bromate and African locust bean every day for 28 days. Twenty-four hours after the last dose, the animals were slaughtered while being softly sedated with diethyl ether. Blood was drawn by puncturing the heart.

2.4 Determination of Male Reproductive Hormones

Serum analysis of hormone Serum level of testosterone, luteinizing hormone (LH), follicle stimulating hormone (FSH), estradiol and prolactin was estimated using RIA gamma counter through kits.

3.RESULTS

Analyses showed that $KBrO_3$ significantly reduced the levels of luteinizing hormone (LH), follicle stimulating hormone (FSH) and testosterone but elevated the levels of prolactin and estradiol when compared with those in the control group. However, groups treated with 100 and 200 mg/kg body weight of African locust bean in conjunction with $KBrO_3$ resisted these perturbations.

Table 1: Effect of African locust beanon Sex Hormones of Potassium Bromate-induced male Rats

Sex Hormones	Control	$KBrO_3$ Only	$KBrO_3$ + 100 mg/kg African locust bean	$KBrO_3$ + 200 mg/kg African locust bean	p-value
FSH (mg/dL)	23.17±2.75	12.58±1.23	16.37±2.39	21.85±3.10	0.00
LH (mg/dL)	27.14±2.28	10.36±1.25	16.82±1.29	25.10±1.22	0.03
Testosterone (mg/dL)	48.43±2.36	23.23±1.83	32.82±2.26	43.73±5.16	0.02
Prolactin (mg/dL)	25.68±3.14	51.28±4.19	42.27±0.17	31.20±2.00	0.03
Estradiol (mg/dL)	40.23±8.12	73.27±7.63	60.14±4.23	47.44±3.85	0.02

Values are presented as Mean±SD, where n = 6.

Legend: FSH = Follicle Stimulating Hormone, LH = Luteinizing Hormone

4. DISCUSSION

Potassium bromate ($KBrO_3$) has been labeled as potentially carcinogenic in numerous animal experimental studies [19,20]. According to studies, rats intoxicated with $KBrO_3$ had greater activities of the enzymes catalase, superoxide dismutase, and acid phosphatase, as well as lower testicular concentrations of total cholesterol, total protein, glycogen, sialic acid, and reduced glutathione [21]. In growing rats, $KBrO_3$ inhibited spermatogenesis, lowered pubertal, testicular, and epididymal weights, and slowed growth [22].

In this study, luteinizing hormone (LH), follicle stimulating hormone (FSH), and testosterone levels were found to be considerably ($p<0.05$) reduced by $KBrO_3$, whereas prolactin and estradiol levels were found to be significantlyelevated when compared to those in the control group. Males who are in the reproductive stage of their lives have pulse-like bursts of gonadotropin-releasing hormone (GnRH) from the hypothalamus every one to three hours. Despite this pulsatile release, the average plasma levels of FSH and LH are rather constant from the beginning of puberty, when levels rise, until the third decade of life, when levels peak and gradually start to drop. Decreased testosterone level before puberty is a reflection of low gonadotropin and GnRH secretion [23]. A sharp increase in GnRH secretion is brought about by changes in the brain's activity and neuronal input to the hypothalamus during puberty. The healthy endocrine interplay of the hypothalamus, pituitary, and testis is essential for the effective and complete development of male germ cells. The pituitary gland releases FSH and LH in response to GnRH, which is released by the hypothalamus. While LH increases testosterone production in Leydig cells, which may then act on the sertoli cells and peritubular cells of the seminiferous tubules to increase spermatogenesis [24].

The findings of this investigation are consistent with those of Khan et al. [25], who treated rats for 30 days with 20 mg/kg of $KBrO_3$. Due to increased oxidative stress and the deterioration of Leydig cells, $KBrO_3$may likely reduce the secretion of testosterone. According to a recent study, $KBrO_3$ caused oxidative stress in many animal tissues [3]. The toxic effects of $KBrO_3$ could prevent the pituitary from secreting FSH and LH, which would cause testicular dysfunction and impair fertility. African locust bean therapy, however, reduced these negative consequences in this investigation.

In this study, it was found that rats exposed to $KBrO_3$ alone had higher serum levels of prolactin than the control group and other animals given African locust bean extract. One endocrine condition that has been linked to male infertility is hyperprolactinaemia [26]. It is a widespread medical disorder that affects 1% of the world's population [27]. Pituitary tumors [28], hypothyroidism [29], macroprolactinemia [30], stress, and other variables [31] have all been linked to high prolactin levels. This could imply that the problems in the treated rats were brought about by $KBrO_3$. Hypogonadism and a decline in semen quality have both been connected to hyperprolactinaemia [26]. This is consistent with the results of Ezirim et al. [32], who reported that 100 mg/kg body weight of $KBrO_3$ decreased the quality of semen in male rats.

The study's findings also demonstrated that, as compared to the control group and other animals given African locust bean extract, the treatment of $KBrO_3$ considerably raised the serum level of estradiol. Estrogen has long been thought of as a female sex hormone [33]. Estradiol, the main type of estrogen, nonetheless, is essential for male sexual activity. Men's spermatogenesis, libido, and erectile function are all controlled by estradiol. The brain, penis, and testis, along with other vital organs for sexual function, are loaded with estrogen receptors and aromatase, the enzyme that converts testosterone into estrogen [34]. In the brain, regions associated with sexual excitement see an increase in estradiol production. Additionally, estrogen receptors are present throughout the corpus cavernosum of the penis, with a concentration that is particularly high surrounding neurovascular bundles. Independent of one another, low testosterone and high estrogen increase the likelihood of erectile dysfunction [35].

The hypothalamus-pituitary-gonadal axis, Leydig, Sertoli, germ cells, ductal epithelium, epididymis, and mature sperm are the final stages of spermatogenesis in the testes, and estrogen regulates it at every stage [33]. Estradiol exerts both an inhibitory and a stimulatory effect on testicular cells, demonstrating a complex symphony of dose-dependent and time sensitive modulation [36].

The hypothalamus-pituitary axis, follicle-stimulating hormone (FSH), and luteinizing hormone (LH) are all inhibited by estrogen, which lowers the level of testosterone in the blood [33]. Testosterone is important for optimal erectile function, and insufficient testosterone induces decreased firmness, ability to maintain erections and number of erections achieved [37]. The elevated concentration of estradiol in $KBrO_3$-treated animals may have contributed to the decreased levels of LH, FSH, and testosterone found in those animals.

It is important to highlight that the changes in sex hormones seen in rats treated with $KBrO_3$ alone were alleviated by the simultaneous administration of $KBrO_3$ and African locust bean extract. This would imply that African locust bean seed extract has anti-toxicity and antioxidant characteristics that could aid to stop pituitary gland cellular damage brought about by reactive oxygen species generated by $KBrO_3$.

5. **CONCLUSION**

In this study potassium bromate increased the levels of estradiol which has been known to inhibit sex hormones. This effect of estradiol on sex hormones; LH, FSH and testosterone is further evidenced by the results of this study. The potential benefit of the African locust bean in the amelioration of perturbation of sex hormones is brought to the fore by the findings of this research. The intake of this legume in our diet is therefore recommended.

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