Ashwagandha (*Withania somnifera*) and Their Effects on the Reproductive Hormones of Male Rats

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Abstract

Effect of Ashwagandha (powder, extract and their mixtures) on feed intake, body weight gains, feed efficiency ratio, lipid profile, liver enzymes, kidney functions and fertility hormones in rats were examined. Forty-two adult male rats weighing (115±5 g) were divided into 2 main groups. The first main group fed on basal diet as a (negative control group) consisted of (7) rats, while the second main group consisted of (35) rats divided into five similar subgroups were injected with sodium valproate to induce testicular injury at a dose (500 mg/kg) body weight. The first subgroup was then maintained as positive control (+Ve), the second subgroup was fed on basal diet plus Ashwagandha powder (100 g/kg diet), the third subgroup was fed on basal diet plus Ashwagandha extract (10 mg/kg b.w/rat) orally, the fourth subgroup was fed on basal diet plus L-carnitine (150 mg/kg b.w/rat) orally, the fifth subgroup was fed on basal diet plus Ashwagandha powder and (Ashwagandha extract & L-carnitine/rat orally) for one month. At the end of the experimental period, blood samples were collected from each rat and separate the serum which used for determination of some biochemical analysis. Tests specimens were taken for examination. The results of Ashwagandha powder, extract and combination orally to rats revealed that non-significant differences in body weight gains, feed efficiency ratio, feed intake and decreased serum lipid profile and increased in HDL-c. It also decreased in liver enzymes, kidney functions and fertility hormones serum Testosterone, Follicle Stimulating Hormone, Lutenizing Hormone in induced rats which feed on combination of Ashwagandha powder, extract and L-carnitine. So this study recommended using Ashwagandha in improving fertility for patients.

Keywords

Ashwagandha, Rats, Fertility Hormones, Lipids profile, Liver enzymes, Kidney functions, Biochemical analysis.

INTRODUCTION

Ashwagandha (*Withania somnifera Dunal*) belonging to Solanaceae family is a small woody shrub or herb that grows to usually 30 to 50 cm height (maximum of 150 cm) **Sapra *et al***., (**2020**). It is an adoptogenic herb and its roots, seeds and leaves are used in ayurvedic and unani medicines to promote "youthful vigor," enhance muscle strength and endurance, and improve overall health **Kulkarni** and **Dhir** (**2008**).

Ashwagandha, also known as *Withania somnifera* , Indian ginseng and winter cherry, has been an important traditional herbal medicine for over 3000 years **Mishra *et al***., (**2005**).

The extract of (*W. somnifera***)** is a complex mixture of a large number of phytochemicals including phenolic compounds and flavonoids. However, the pharmacological effect of the roots of *W. somnifera* is attributed to withanolides **Udayakumar *et al***., (**2010**) . Polyphenols are the biggest group of phytochemicals, and many of them have been found in plant-based foods. Polyphenols have been found to be strong antioxidants that can neutralize free radicals by donating an electron or hydrogen atom **Rice-Evans *et al***., (**2000**). In addition to radical scavenging, polyphenols chelate metal ions such as Fe+2 directly and reduce the rate of Fenton reaction, thus preventing oxidation caused by highly reactive hydroxyl radicals **Perron** and **Brumaghim** (**2009**).

The extract of the Ashwagandha root has many biological implications due to its diverse phytochemicals **Dar *et al***., (**2015**), so it has been used, singly or in combination with other natural plants, in many research studies for its properties: anti-diabetic **Chukwuma *et al***., (**2019**), anti-inflammatory **Sun *et al***., (**2016**), anti-microbial **Tripathi *et al***., (**2018**), anti-tumor **Hassannia *et al***., (**2019**), anti-stress **Kaur *et al***., (**2001**), cardioprotective **Kaur *et al***., (**2015**), or neuroprotective **Yenisetti *et al***., (**2016**). It also displays enhanced endothelial function **Dar *et al***., (**2015**), reduces reactive oxygen species **Sun *et al***., (**2016**), regulates apoptosis **Ahmed *et al***., (**2018**), and modulates mitochondrial function **Dar *et al***., (**2015**), showing to be effective to treat aging effects **Pradhan *et al***., (**2017**), cognitive functions and memory **Choudhary *et al***., (2017), skin diseases **Li *et al***., (**2016**) and thyroid function, **Sharma *et al***., (**2018**),

Ashwagandha has the antioxidant property that can reduce free radicals induced oxidative stress; **Singh *et al***., (**2002**); **Mishra** (**2009**[a]) and **Bhattacharya *at al***., (**2010**). Thus, some of the useful effects of dietary intake Ashwagandha roots on triglyceride level are attributable to the reduction of stress oxidative and lipid peroxidation.

hormones regularly occur as men age. After the age of 40, as an average males experience a decrease in testosterone levels at the rate of 1%–2% per

annum **Stanworth** and **Jones**, (**2008**). Dehydroepian- drosterone sulfate (DHEA-S) concentrations also decline by an average of 1%–4% per year between the ages of 40 and 80 **Walther *et al.,*** (**2016**). Testosterone and DHEA have several important roles in the body as they affect sexual health, lean body mass, mental health, cognition, bone density, cardiovascular function, and metabolic activity, just to name a few **Kelly** and **Jones** (**2013**) and **Rutkowski *et al***., (**2014**). Testosterone can be turned by the enzyme aromatase into estradiol. Estradiol is a hormone that is usually associated with females, it also drops down as men age **Orwoll *et al***., (**2006**). It has several crucial roles in males, which involves a crucial impact in male sexual function, levels of adiposity, neurological activity, immunity and cardiovascular health **Schulster *et al***., (**2016**) and **Cooke *et al***., (**2017**).

Adding aqueous extract of Ashwagandha had a huge effect. As the FSH serum level declined and LH level increased in rats **Abdel-Magied *et al***., (**2001**). Besides, it has been proven that this administration had a major impact in men as both serum and LH levels increased & FSH levels decreased **Ahmad *et al***., (**2009**). Furthermore, some studies have shown that aqueous extract of Ashwagandha causes some hypophysial gonadotropines to change as well as sperms in male rats and foliclegenesis in immature female rats to increase **Al-Qarawi *et al***., (**2011**).

This study was conducted to investigate the effect of the Ashwagandha (*Withania somnifera*) and their effects on the reproductive hormones of male rats.

Materials and Methods

Materials

-Ashwagandha was obtained from Agriculture Research Center, Dokki, Giza, Egypt.

- Casein, cellulose, choline chloride powder, vitamins, minerals, DL methionine powder, L-Carnitine and Sodium valproate were purchased from El-Gomhoria Company for chemical, Drugs and Medical Instruments, Assiut, Egypt. Oil and corn starch were obtained from local market in Assiut, Egypt. The kits were supplied by Bio Diagnostics Company Cairo, Egypt.
- Forty-two adult male albino rats Sprague Dawley strain weighing (115±5g) were obtained from the animal house of the Faculty of Medicine, Assiut University.

Methods

Preparation of Ashwagandha extract

Ashwagandha was prepared daily as tea by steeping in boiling water for 5 minutes. It was given to rats at dose (10 mg/kg. Bwt /rat).

Scavenging effect on 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radicals

The effect of Ashwagandha on DPPH radical was studied, employing the modified method described earlier by **Yamaguchi *et al***., (**1998**). Briefly, 1.5 ml of DPPH solution (0.1 mM, in 95% Ethanol) was incubated with varying concentrations of the extract (Ashwagandha, 0.75 - 5.0 mg).The reaction mixture was shaken well and incubated for 20 min at room temperature and the absorbance of the resulting solution was read at 517 nm a gains a blank. The radical scavenging activity was measured as a decrease in the absorbance of DPPH and was calculated using the following equation:

$$\text{Scavenging effect \%} = \frac{\text{A Sample (517nm)} \times 100}{\text{A Control (517nm)}}$$

Experimental design

Forty-two adult male albino rats, weighing 115±5g were used in the study. The animals were obtained from the animal house of the Faculty of Medicine, Assiut University, Rats were housed in individual stainless steel cages under controlled environmental conditions, in the animal house and fed one week on basal diet according to **Reeves *et al***., (**1993**). After the adaptation period, the experimental animals were divided into 2 main groups. The first main group fed on basal diet as a (negative control group) consisted of (7) rats, while the second main group consisted of (35) rats divided into five similar subgroups were injected with sodium valproate to induce testicular injury as described by **Bairy *et al***., (**2010**) at a dose (500 mg/kg) body weight. The first subgroup was then maintained as positive control (+Ve), the second subgroup was fed on basal diet plus Ashwagandha powder (100 g/kg diet), the third subgroup was fed on basal diet plus Ashwagandha extract (10 mg/kg b.w/rat) orally, the fourth subgroup was fed on basal diet plus L-carnitine (150 mg/kg b.w/rat) orally, the fifth subgroup was fed on basal diet plus Ashwagandha powder and (Ashwagandha extract & L-carnitine / rat orally) for one month.

During the experimental period (30 days), each rat was weighed every week and food consumption was recorded. The body weight gain% (BWG%) and food efficiency ratio (FER) were estimated outlined by **Chapman *et al***., (**1959**). At the end of the experimental period rats were fasted over night before sacrificing blood was collected then centrifuged serum was separated and stored at -20^{o} C for biochemical analysis.

Biochemical Analysis

Lipids profile

Serum total cholesterol (TC), triglycerides (TG), high density lipoprotein (HDL-c), low density lipoprotein (LDL-c) and very low density lipoprotein (VLDL-c) were determined according to the colorimetric method described by **Roeschlau *et* al.,** (**19**74) & **Fossati** and **Principe**, (**1982**).

Calculation of very low density lipoprotein cholesterol (VLDL-c)

VLDL-c was calculated in mg/dl according to **Lee** and **Nieman** (**1996**) was using the following formula:

VLDL-c (mg/dl) = Triglycerides / 5

Determination liver functions

Determination of serum alanine amino transferase (ALT), serum asparatate amino transferase (AST), serum alkaline phosphatase (ALP) were carried out according to the method of **Hafkenscheid** (**1979**); **Clinica Chimica Acta** (**1980**) and **Moss** (**1982**); respectively.

Determination of kidney functions

Serum urea and serum creatinine were determinate by enzymatic method according to **Henary** (**1974**); **Patton** and **Crouch** (**1977**) & **Han *et al***., (**1984**).

Determination of serum fertility hormones

Testosterone (T), Lutenizing Hormone (LH) and Follicle Stimulating Hormone (FSH) were determined according to the method of **Maruyama**, (**1987**).

Determination of the gonadosomatic Index

The body weight of each rat was determined immediately before sacrificing. After sacrifice and dissection, the testes were removed, and individual testes were weighed to determine the gonadosomatic index according to the method of **Anderson *et al***., (**1983**).

Tissue sampling for biochemical analysis

Immediately after weighing the genitalia, each testis was homogenized for the biochemical analysis of antioxidant enzymes, including superoxide dismutase activity (SOD), glutathione activity (GSH) were determined according to **Beutler *et al***., (**1963**) and **Nishikimi *et al***., (**1972**); respectively.

Statistical analysis

The obtained data were statistically analyzed using computerized **SPSS**, (**1988**). Effects of different treatments were analyzed by one way ANOVA (Analysis of variance) test using Duncan's multiple range test and $p<0.05$ was used to indicate significance between different groups as described by **Snedecor** and **Cochran** (**1967**).

Results and Discussion

(DPPH) radical scavenging activity % of Ashwagandha extract was shown in **Table (1)**. The measured radical scavenging activity % of Ashwagandha extract were 59.73, 87.46, 90.43 and 96.06; respectively

DPPH is a stable free radical that easily accepts an electron or hydrogen, when an antioxidant reducing agent reacts with the DPPH which converts it to α, α-diphenyl-β picryl hydrazine and solution losses its colour depending upon the number of electrons taken up **Shahriar *et al***., (**2013**). The radical scavenging activity of *Withania somnifera* in the present study was similar to the reports of **Kumar *et al***., (**2018**). Who found radical scavenging activity could be due to content of phenols in the extracts. The antioxidant activity of phenolics is mainly due to their redox properties which make them act as reducing agents, hydrogen donors and singlet oxygen quenchers and also may have a metallic chelating potential **Rice-evans *et al***., (**1995**).

Data presented in **Table (2)** show the effect of Ashwagandha powder, extract, L-carnitine and their combination of them on body weight gain, feed intake and feed efficiency ratio on rats. It is clear to notice that, the mean value of body weight gain (g) of positive control group (+Ve) was significantly lower than negative control group (-Ve), which were 55.64 and 101.76 g; respectively. Also, the mean value of treated subgroups 3, 4, 5 and 6 recorded a significant increased in body weight gain, which were 83.59, 85.13, 88.77 and 93.44 g; respectively, with significant difference when compared with positive control (+Ve). The best result were recorded for subgroup (6) which fed on basal diet with Ashwagandha powder, extract and L-carnitine & combination of them.

As for feed intake and feed efficiency ratio it could be noticed that the mean value of positive control group (+Ve) was significantly lower than that of negative control group, which were 13.94 & 17.94 g/day and 0.06 & 0.10; respectively. The mean value of treated subgroups 3, 4 and 5 indicated non-significant differences between them and a significant difference when compared with positive control group (+Ve) which were 16.80, 16.66, 16.65 and 0.09, 0.08, 0.09 in feed intake and feed efficiency ratio; respectively. These results are agreement with **Malik *et al***., (**2013**) who found that the Ashwagandha to improve cardiorespiratory fitness can be the significant effects observed on mitochondrial and energy levels, by reducing the succinate dehydrogenase enzyme activity in the mitochondria and benefiting Mg-ATPase activity **Begum** and **Sadique** (**1987**). Previous studies showed that Ashwagandha significantly enhanced the hemoglobin concentration and red blood cells in animals **Ziauddin *et al***., (**1996**) and also in humans , with the

subsequent increase in the capacity to transport oxygen to the muscles. Moreover, it should be considered that Ashwagandha has shown to have anti-fatigue **Mishra** (**2003**) and **Biswal *et al***., (**2013**) and anti-stress **Lopresti *et al***., (**2019**) actions.

The effect of Ashwagandha powder, extract, L-carnitine and combination of them on the serum cholesterol, triglyceride, high density lipoprotein (HDL-c), low density lipoprotein (LDL-c) and very low density lipoprotein (VLDL-c) of rats are shown in **Table (3)**. The obtained results showed that the mean value of TC of positive control group (+Ve) was significantly higher the negative control group (-Ve), which were 180.19 mg/dl and 120.21 mg/dl; respectively. The mean values of treated subgroups 3, 4, 5 and 6 were 116.27, 117.14, 125.48 and 103.27 mg/dl; respectively and showed a significant difference when compared with positive control group (+Ve).

Concerning triglycerides, results showed that the mean value of serum triglycerides of positive control group (+Ve) was significantly higher than negative control group (-Ve), it was 80.43 and 50.03 mg/dl; respectively. The mean values of treated subgroups 3, 4, 5 and 6 were 55.27, 56.17, 64.32 and 56.19 mg/dl; respectively and showed a significant difference when compared with positive control group (+Ve). The best result was recorded for subgroup (3). These results agreement with **Mishra *et al***., (**2009**[b]) who found that triglyceride level indicate VLDL metabolism decrease in serum triglycerides level is indicative of decreased formation and increased utilization. Ashwagandha per se may have enhancement of triglycerides utilization in the body leading to decrease in its level in serum.

On the other hand, the mean value of HDL-c of positive control group (+Ve) was significantly lower than negative control group (-Ve); it was 14.58 and 46.86 mg/dl; respectively. The mean values of treated subgroups 3, 4, 5 and 6 were 34.97, 33.60, 32.02 and 31.97 mg/dl and showed a significant difference when compared with positive control group (+Ve).

As for LDL-c results showed that the mean value for positive control group (+Ve) was significantly higher than negative control group (-Ve), which was 149.52 and 63.34 mg/dl; respectively. The mean values of treated subgroups 3, 4, 5 and 6 were 70.25, 72.31, 80.60 & 60.06 mg/dl and showed a significant difference when compared with positive control group (+Ve).

Concerning VLDL-c, results indicated that the mean value of positive control group (+Ve) was significantly higher than negative control group (-Ve). Which were 16.09 and 10.01 mg/dl; respectively. The mean values of treated

subgroups 3, 4, 5 and 6 were 11.05, 11.23, 12.86 and 11.24 mg/dl and showed a significant difference when compared with positive control group (+Ve).

Our results are agreement with **Anwer *et al***., (**2017**) who reported the *Withania Somnifera* (WS) (200 and 400 mg/kg) was administered orally once a day for 5 weeks, resulted in a significant ($P < 0.001$) reduction in glucose, TC, TG, LDL-c, VLDL-c levels with significant elevation of HDL-c levels.

Jha and **Paul** (**2020**) reported that the (*Withania Somnifera*) at the dose of 1000 mg/Kg b.w. was orally administered for 4 weeks. The lipid profile study showed inclination in the Total cholesterol level (117±6.686 mg/dl), Cholesterol (LDL) (78.83±4.151mg/dl), level and Triglycerides level (60.83±2.613mg/dl), while declination in Cholesterol (HDL) (13.50±1.33mg/dl), level after Endosulfan exposure. But, upon *W. somnifera* treatment to the endosulfan treated group showed significant ($P<0.001$) normalization in the lipid profile levels.

Data given in **Table (4)** show the mean values of AST liver enzyme level (u/l) of rats fed on various diets. It could be noticed that the mean values of AST liver enzyme level of control (+Ve) group was higher than control (-Ve) group with a significant difference, it was 193.57 and 80.80 u/l; respectively. All rats fed on various diets, showed significant differences in mean values as compared to control (+Ve) group with a significant difference. The values were 126.86, 123.08, 125.82 and 118.08 (u/l); respectively. The best treatment AST liver enzyme level (u/l) was recorded for subgroup 6 fed on basal diet with combination of Ashwaganha powder, extract and L-carnitine.

Concerning ALT enzyme results indicated that the mean values of positive control group (+Ve) was significantly higher than that of negative control group (-Ve), which was 142.86 and 65.21 (u/l); respectively with significant difference. On the other hand, the mean values of treated subgroups fed on Ashwaganha powder, extract, L-carnitine and their combination were lower than positive control group which were 74.76, 72.03, 80.75 and 65.83 (u/l); respectively. Rats in subgroup (6) fed on combination of L-carnitine and Ashwaganha (powder & extract) showed non-significant difference as compared with negative control group (-Ve) and recorded the best treatment.

As for ALP enzyme, it could be noticed that the mean value of positive control group (+Ve) was significantly higher than of negative control group (-Ve), which were 164.39 and 96.26 (u/l); respectively with significant difference. The mean value of treat subgroups 3, 4, 5 and 6 were lower than positive control group (+Ve) which were 119.33, 124.74, 128.89 and 114.74 (u/l); respectively. The best result was recorded for subgroup (6) rats fed on

combination of Ashwaganha powder, extract and L-carnitine. These results supported by published by **Ichikawa *et al***., (**2006**) who found Ashwagandha root extract contains withanolides, which have anti-inflammatory property, thus may be helpful in protecting the liver damage and can decrease its weight. Also, **Sultana *et al***., (**2012**) reported that there were significantly lower levels of serum AST and ALT which come almost normal level in the Ashwagandha pretreated and gentamicin treated rats provides an evidence that, this root extract may have hepatoprotective effects against gentamicin toxicity. All these effects are most likely due to presence of some active ingredients in Ashwagandha root which have antioxidant property.

Data tabulated in **Table (5)** show the mean value of kidney functions (uric acid, urea and creatinine) level (mg/dl) of rats fed on various diets. It could be noticed that the mean value of uric acid (mg/dl) level of positive control group (+Ve) was higher than control negative control group (-Ve), it was 5.20 and 1.53 mg/dl; respectively with a significant difference. All rats fed on various diet, showed significant differences in mean values as compared to control positive (+Ve) group. The values were 2.79, 2.82, 2.07 and 1.98 mg/dl; respectively.

On the other hand, it could be noticed that the mean value of urea (mg/dl) level of control (+Ve) group was higher than control (-Ve) group, it was 40.93 and 25.88 mg/dl; respectively with a significant difference. All rats fed on various diets, showed significant differences in mean values as compared to control (+Ve) group. The values were 34.14, 31.17, 30.21 and 31.90 mg/dl; respectively. Numerically, the best treatment urea level (mg/dl) was recorded 30.21 mg/dl for subgroup (5) fed on basal diet with L-carnitine (150 mg/kg) when compared to control (+Ve) group.

In case of creatinine level, it could be noticed that the mean value (mg/dl) of control (+Ve) group was higher than control (-Ve) group, it was being 5.62 and 1.16 mg/dl; respectively with a significant difference. Rats in subgroups 3, 4, 5 and 6 fed on variance diet showed significant differences in mean values as compared to control (+Ve) group. The values were 3.87, 2.83, 2.72 and 2.65 mg/dl; respectively. Numerically, the best treatment creatinine level was recorded for subgroup (6) fed on basal diet with combination of Ashwagandha, powder, extract and L-carnitine when compared to positive control group (+Ve). The results are agreement with that obtained by **Rahman *et al***., (**2019**) who said treated male and female rats of Ashwagandharishta showed a trend of increment (although it was not statistically significant) in the three parameters 0.625, 5.0 and 40.0 ml/kg of body weight, serum urea, creatinine and uric acid than their corresponding control group. But a

statistically significant increase was observed in serum urea in all three doses of Ashwagandharishta treated female rats (low: ↑ 17.18 %*, medium: 14.85 %* and high:↑ 24.15 %,*. For the serum creatinine level, a statistically significant increase was observed only for the medium dose male rat (↑ 67.979 %*) than their corresponding control group. And no statistically significant increase was observed for the uric acid level.

Data tabulated in **Table (6)** show the effect of Ashwagandha powder, extract, L-carnitine and combination of them, on the reproductive hormones of male rats. Concerning testis weight (g/100g), data revealed that the mean value of positive control group (+Ve) was significantly lower than that of the negative control group (-Ve). On the other hand the mean values of subgroups 3, 4, 5 and 6 were 1.85, 1.95, 1.55 and 1.60 (g/100g); 0.73, 0.72, 0.71 and 0.73; 59.33, 55.25, 45.42 and 60.50 (10^6/ml) in testis weight, gonado somatic and sperm number; respectively, which are higher than the positive control (+Ve). Subgroup (4) showed the best result was recorded 1.95 g/100g on testis weight and subgroup (5) was 0.71 on gonado somatic when compared with the negative control group (-Ve), while sperm number was 60.50 in subgroup (6) when compared the negative control group (-Ve).

Data in **Table (7)** showed that positive control group (+Ve) had lower serum testosterone, folicle stimulating hormone and luteinizing hormone when compared with negative control group (-Ve), while subgroup (6) fed on basal diet with combination of Ashwagandha powder, extract and L-carnitine, showed higher values in testosterone, folicle stimulating hormone and luteinizing hormone when compared with the positive control group (+Ve). Our results agreed with **Sahin *et* al**., (**2016**) who said all of the extracts were found to be significantly effective in sexual functioning and antioxidant capacity. Ashwagandha supplementation improves sexual function in male rats via activating Nrf2/ HO-1 pathway while inhibiting the NF-κB levels.

Low serum testosterone levels in men are strongly related to the increase in morbidity **Maggi *et al.,*** (**2007**) and men are commonly in accordance with major depressive disorder **Joshi *et al***., (**2010**), cardiovascular disease, obesity **Di Vincenzo *et al***., (**2018**); **Traish** and **Zitzmann** (**2015**), and type 2 diabetes **Yao *et al***., (**2018**). Lower testosterone concentrations have a negative impact on the quality of life **Khera**, (**2016**).

The data given in **Table (8)** revealed that there were significant differences at ($P<0.05$) between positive control group (+Ve) and negative control group (-Ve) these results recorded significant increase in total antioxidant, superoxide dismutase enzymes (SOD) and plasma glutathione transferase (GST) in the negative control group compared with the positive

control group (+Ve). All treated groups recorded significant increase in these parameters, as compared to the positive control group. These results is agreement with **Mishra**, (**2000**) and **Singh *et al.*,** (**2010**), which reported that Ashwagandha root contains sitoindosides VIIX and withaferin A, have antioxidant activity by enhancing the free radical scavenging enzymes such as, superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx).

It has been reported that phenolic compounds show antioxidant properties in vivo via modulation of glutathione (GSH) content, superoxide dismutase (SOD), catalase (CAT) activities, and malondialdehyde equivalent (MDA) **Sasidharan *et al***., (**2010**). Therefore, phenolic compounds from medical plants can be used as antioxidant agents for preventing, reversing and delaying the occurrence and development of tumors. Flavonoids and phenolic acids all contain hydroxyl groups that play a role in scavenging free radicals. These phenolic compounds were metabolized in vivo via many bio-activating enzymes **Jirovsky *et al***., (**2007**).

Table (1): Effect (DPPH) radical scavenging activity (%) of Ashwagandha extract.

Parameters	0.5 mg	1mg	1.5mg	2mg
DPPH	59.73±3.07	87.46±1.2	90.43±1.69	96.06±0.94

SD: standard Deviation.

Table (2): Effect of Ashwagandha, powder, extract, L-Carnitine and their combination on nutritional parameters of rats.

Parameters / Groups	Body weight gain (g)	Feed intake (g/day)	FER
Control (-Ve)	101.76±8.11a	17.94± 2.20 a	0. 10±0.03a
Control (+Ve) Subgroup 1	55.64±8.11d	13.94± 2.20d	0. 06±0.06d
Ashwagandha powder (100 mg/kg) Subgroup 2	83.59± 6.11 c	16.80± 2.03 a	0.09±0.02 c
Ashwagandha extract (10 mg/kg) Subgroup 3	85.13±9.13 c	16.66±2.32 a	0.08±0.04c
L –Carnitine (150 mg/kg) Subgroup 4	88.77±9.17 c	16.65±2.21 a	0.09±0.03c
L –Carnitine+Ashwagandha (powder and extract) Subgroup 5	93.44±9.17 b	17.68±2.92 a	0.09±0.04 b

Means with different letters in each column are significantly different at $P < 0.05$.
SD: standard Deviation.

Table (3): Effect Ashwagandha, powder, extract, L-Carnitine and their combination on lipids profile of rats.

Parameters / Groups	TC. (mg/dl)	TG. (mg/dl)	HDL-c (mg/dl)	LDL-c (mg/dl)	VLDL-c (mg/dl)
Control (-Ve)	120..21± 24.33 a	50.03± 12.62 a	46.86± 3. 11 a	63.34± 3.61 a	10.01± 0.97a
Control (+Ve) Subgroup 1	180.19± 27.12 d	80.43± 14.82 d	14.58± 2.54 d	149.52± 7.91d	16.09± 1.81d
Ashwagandha powder (100 mg/kg) Subgroup 2	116.27± 26. 54 b	55.27± 23.03 b	34.97± 2.66 b	70.25± 4. 72b	11.05± 1.01b
Ashwagandha extract (10 mg/kg) Subgroup 3	117.14± 27.65 b	56.17± 24.34 b	33.60± 1.93 b	72.31 ± 5.13b	11.23± 1.04b
L –Carnitine (150 mg/kg) Subgroup 4	125.48± 4. 28 c	64.32± 3.08 c	32.02± 2.76 b	80.60 ± 6.31c	12.86± 1.43c
L –Carnitine+ Ashwagandha (powder and extract) Subgroup 5	103.27± 4. 54 b	56.19± 3.46 b	31.97± 2.75 bc	60.06± 4.98a	11.24± 1.32b

Means with different letters in each column are significantly different at $P < 0.05$.
SD: standard Deviation.

Table (4): Effect of Ashwagandha, powder, extract, L-Carnitine and their combination on liver functions of rats.

Parameters / Groups	AST (u/l)	ALT (u/l)	ALP (u/l)
Control (-Ve)	80.80± 2.11 a	65. 21± 1. 78 a	96. 26± 3.97 a
Control (+Ve) Subgroup 1	193.57± 5.58 d	142.86± 3. 27 d	164.39± 6.49 d
Ashwagandha powder (100 mg/kg) Subgroup 2	126.86± 4.75 b	74.76± 3. 13 b	119.33± 3.65 b
Ashwagandha extract (10 mg/kg) Subgroup 3	123.08± 4.28 b	72. 03± 3.43 b	124.74± 5.65 b
L –Carnitine (150 mg/kg) Subgroup 4	125.82± 3.02 b	80. 75± 2.14 c	128.89± 2.62 b
L –Carnitine + Ashwagandha (powder and extract) Subgroup 5	118.08± 4.28 b	65. 83± 3.43 b	114.74± 5.65 b

Means with different letters in each column are significantly different at $P < 0.05$.
SD: standard Deviation.

Table (5): Effect of Ashwagandha, powder, extract, L-Carnitine and their combination on kidney functions of rats.

Parameters / Groups	Uric acid (mg/dl)	Urea (mg/dl)	Creatinine (mg/dl)
Control (-Ve)	1.53± 0.78 e	25.88±4.72 e	1.16± 1.18 e
Control (+Ve) Subgroup 1	5.20±0.52 a	40.93±3.20 a	5.62±2.47 a
Ashwagandha powder (100 mg/kg) Subgroup 2	2.79±0.72 bc	34.14±3. 29 b	3.87±1.32 b
Ashwagandha extract (10 mg/kg) Subgroup 3	2.82±0.57 b	31.17±3.59 c	2.83±1.25 c
L –Carnitine (150 mg/kg) Subgroup 4	2.07±0.93 c	30.21±3.43 c	2.72±1.15 c
L –Carnitine + Ashwagandha (powder and extract) Subgroup 5	1.98±0.14 d	31.90±2.38 c	2.65±0.13 d

Means with different letters in each column are significantly different at $P < 0.05$.
SD: standard Deviation.

Table (6): Effect of Ashwagandha, powder, extract, L-Carnitine and their combination on serum testis weight, gonado somatic and sperm number of rats.

Parameter / Groups	Testis weight (g/100g b.wt)	Gonado somatic index	Sperm number (106/ml)
Control (-Ve)	2.22±0.23a	0.68±0.07 c	74.25±18.01a
Control (+Ve) Subgroup 1	1.1±0.20 d	0.40±0.03d	25..33±3.09d
Ashwagandha powder (100 mg/kg) Subgroup 2	1.85±0.20 b	0.73±0.07 b	59.33±24.09b
Ashwagandha extract (10 mg/kg) Subgroup 3	1.95±0.26b	0.72±0.16 b	55.25±15.01b
L –Carnitine (150 mg/kg) Subgroup 4	1.55±0.14c	0.71±0.06 b	45.42±20.01c
L –Carnitine + Ashwagandha (powder and extract) Subgroup 5	1.60±0.26c	0.73±0.11 b	60.50±14.29b

Means with different letters in each column are significantly different at $P < 0.05$.
SD: standard Deviation.

Table (7): Effect of Ashwagandha, powder, extract, L-Carnitine and their combination on serum fertility hormones of rats.

Parameter / Groups	T. T (ng/mL)	FSH (ng/mL)	LH (ng/mL)
Control (-Ve)	30.2±1.7 a	155.38±6.75 a	4.9±0.76 a
Control (+Ve) Subgroup 1	16.03±2.01 d	98.17±7.55 d	1.8±1.16 d
Ashwagandha powder (100 mg/kg) Subgroup 2	20.12±3.01 b	118.98±0.65 b	2.92±0.96 c
Ashwagandha extract (10 mg/kg) Subgroup 3	19.33±14.81c	114.42±0.80 c	2.54±0.52 c
L –Carnitine (150 mg/kg) Subgroup 4	21.01±14.10 b	116.60±0.09 c	2.47±0.37 c
L –Carnitine + Ashwagandha (powder and extract) Subgroup 5	25.81± 19.64 b	125.59±0.80 b	3.8±0.96 b

Means with different letters in each column are significantly different at $P < 0.05$.
SD: standard Deviation.
T.T: Testosterone , FSH: Folicle Stimulating Hormone , LH: Lutenizing Hormone

Table (8): Effect of Ashwagandha, powder, extract, L-Carnitine and their combination on serum total antioxidants, superoxide dismutase and glutathion of rats.

Parameters / Groups	Total Antioxidants (U/mg)	SOD (U/mg)	GSH (U/mg)
Control (-Ve)	5.4±0.75 a	1.67±0.1 a	0.14±0.01 a
Control (+Ve) Subgroup 1	1.17±0.55 d	0.33±0.01 d	0.10±0.01 d
Ashwagandha powder (100 mg/kg) Subgroup 2	2.98±0.65 b	1.0±0.04 b	0.15±0.04ab
Ashwagandha extract (10 mg/kg) Subgroup 3	2.58±0.80 b	1.2±0.06 b	0.13±0.06ab
L –Carnitine (150 mg/kg) Subgroup 4	2.61±0.09 b	0.90±1.10 c	0.12±1.10 b
L –Carnitine + Ashwagandha (powder and extract) Subgroup 5	3.69±1.80 ab	1.33±0.08 ab	0.18±0.08ab

Means with different letters in each column are significantly different at $P < 0.05$.
SD: standard Deviation.
SOD: Superoxide dismutase GSH: Glutathion

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الملخص العربي

الأشواجندا وتأثيرها على الهرمونات التناسلية لذكور الجرذان

تم دراسة تأثير الأشواجندا (مسحوق، مستخلص، خليط منهما) على المأخوذ الغذائي ومعدل كفاءة الغذاء وزيادة وزن الجسم ودهون الدم ووظائف الكبد والكلى وهرمونات الخصوبة في سيرم الجرذان. تم تقسيم أثنين وأربعين من ذكور الفئران البالغة والتي يتراوح أوزانها ما بين (١١٥ ±٥ جم) إلى مجموعتين رئيسيتين. المجموعة الأولى الرئيسية تم تغذيتها على نظام غذائي أساسي كمجموعة ضابطة سالبة وتتكون من (٧) فئران بينما المجموعة الثانية الرئيسية تتكون من (٣٥) من الفئران قسمت إلى خمسة مجموعات فرعية متساوية تم حقنهم بمادة صوديوم فالبورات لإصابة الخصية بجرعة (٥٠٠ ملجم/كجم). المجموعة الأولى الفرعية المصابة تم الاحتفاظ بها كمجموعة ضابطة موجبة، المجموعة الثانية الفرعية المصابة تم تغذيتها على النظام الغذائي الأساسي مضاف له مسحوق الأشواجندا (١٠٠ جم/كجم) من الغذاء، المجموعة الثالثة الفرعية المصابة تم تغذيتها على النظام الغذائي الأساسي ومستخلص الأشواجندا (١٠ ملجم/كجم) من وزن الجسم لكل فأر بالفم، المجموعة الرابعة الفرعية تم تغذيتها على النظام الغذائي الأساسي والكارنتين (١٥٠ ملجم/كجم) من وزن الجسم لكل فأر بالفم، والمجموعة الخامسة الفرعية تم تغذيتها على النظام الغذائي الأساسي مضاف له مسحوق الأشواجندا وإعطاء مستخلص الأشواجندا والكارنتين لكل فأر عن طريق الفم لمدة شهر. وفي نهاية التجربة تم جمع عينات الدم لفصل السيرم المستخدم في التحاليل البيوكيميائية، كما أخذت عينة من الخصية لإجراء الفحوص عليها. وأوضحت النتائج عدم وجود فروق معنوية في المأخوذ الغذائي ومعدل كفاءة الغذاء وزيادة نسبة وزن الجسم وإنخفاض مستويات السيرم من الكوليسترول الكلي (TC) والدهون الثلاثية (TG) والبرويتينات الدهنية منخفضة الكثافة (LDL–c)، والبروتينات الدهنية منخفضة الكثافة جداً (VLDL–c)، وزيادة في البروتينات الدهنية عالية الكثافة (HDL–c). كما حدثت انخفاض في إنزيمات الكبد، ووظائف الكلى. كما زادت هرمونات الخصوبة في السيرم من Testosterone, Follicle Stimulating Hormone, Lutenizing Hormone في الفئران المصابة التي تغذت على خليط من مسحوق ومستخلص الأشواجندا والكارنتين.

لذا توصي الدراسة باستخدام الأشواجندا لتحسين هرمونات الخصوبة للمرضى.

الكلمات المفتاحية

الأشواجندا، الفئران، هرمونات الخصوبة، دهون الدم، إنزيمات الكبد، وظائف الكلى، التحاليل الكيميائية الحيوية.