To achieve the objectives of the study the research worker has to plan the entire process of the work in term of research design suited to the study. Therefore the design of the present study systematically under the following headings:

1. Selection of Subjects
2. Variables Studied
3. Method of Ashwagandha Supplementation
4. Tools used for the collection of data
5. Collection of data
6. Statistical techniques used

1. Selection of Subjects

The present randomized controlled, parallel group, single blinded study was conducted on forty eight male hockey players, with a mean age of 17.4 ± 1.7 (aged between 16 to 19 years) years and BMI 20.9 ± 2.9 kg/m² from Shri Guru Hari Singh Hockey Academy, Shri Jiven Nager, Sirsa, Haryana, who volunteered for the study. Subjects were randomly assigned into two groups using the chit in a box method, Group I (n=24): Withania Somnifera Group(Experimental) and Group II (n=24): Placebo (Control) group. Withania somnifera was used in the form of a standardized aqueous root extract was obtained from Central Council for Research in Ayurveda and Siddha (CCRAS), Delhi, India. Prior to the start of data collection, participants were explained about the drugs and previous research supporting the effectiveness on physical performance and possible side effects due to overdose. Only then the subjects who volunteered to participate in the study were recruited. A written informed consent was taken from each participant and their parent prior to recruitment.
Table No. - 3.1

Categorization of Subjects for Control and Experimental Group

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Category</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Withania Somnifera Group (Experimental Group)</td>
<td>24</td>
</tr>
<tr>
<td>2.</td>
<td>Placebo Group (Control Group)</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>48</td>
</tr>
</tbody>
</table>

2. **Variables Studied**

   In the present study effect of Ashwagandha supplementation on following specific variables of physical fitness and one physiological variable upon which performance of a hockey player is directly related were studied:

   i) **Specific variables of Physical Fitness**

   a) Maximal Oxygen Consumption Capacity (VO\textsubscript{2max}) in ml/kg/min.

   b) Sprint Fatigue Level

   c) Core Muscle Strength & Stability

   d) Lower Back and Hamstring Flexibility

   e) Agility

   ii) **Physiological Variable:** Haemoglobin Concentration in Blood

3. **Method of Ashwagandha Supplementation**

   Quality and dose of Withania Somnifera (WS) known as Ashwagandha was decided after consultation with the Ayurvedic Medical Officer of Civil Hospital, Sirsa (Haryana). Who prescribed a dose of 500mg roots powder of Withania Somnifera (WS) for each subjects. Withania Somnifora was used in the form of a standardized aqueous root extract was obtained from Central Council for Research in Ayurveda and Siddha (CCRAS), Delhi, India. The dose (500mg) as prescribed by the doctor and sugar power was filled in gelatin
capsules and stored in air tight containers and in room temperature below 30°C throughout the experiment. Drug and sugar capsules were given to the respective groups (Experimental and Controlled) in the dose of 1 capsule/day orally with milk after meals at night for 8 weeks under the personal supervision of researcher. Subjects were unaware of which group they were in and which drug they were to receive. It was thus a single blinded study, where all the subjects were completely unaware of drugs which they were going to consume. Maximal Oxygen Consumption Capacity (VO$_{2\max}$) in ml/kg/min, Sprint Fatigue Level, Core Muscle Strength & Stability, Flexibility, Agility and level of blood haemoglobin in both experimental and control groups were measured before, after 4 week and 8 week of Withania Somnifora and placebo administration.

4. Tool Used for the Collection of Data

Following tools were used for the collection of data for different variables:

a) Maximal Oxygen Consumption Capacity (VO$_{2\max}$) in ml/kg/min was measured with Cooper (1968) 12 min. run test (VO$_{2\max}$. = (22.351 x Distance run in km) - 11.288)

b) Sprint Fatigue Level was calculated with Mackenzie B. (2006) 40 Metre Multiple Sprint Test.

c) Core Muscle Strength & Stability was assessed with Mackenzie B. (2002) Core Muscle Strength and Stability Test. Brian Mackenzie in 2002 developed Core Muscle Strength and Stability test to determine core strength. Hockey is a game which involves frequent high speed Zig - Zag movement with bend and straight torso. Thus good core strength indicates that a hockey player can move with high efficiency.

d) Lower Back and Hamstring Flexibility was measured with Mackenzie B. (2000) Sit and Reach Test.

e) Agility of the subjects was evaluated with Illinois Agility Run Test Getchell (1979).
ii) **Physiological Variable:** Haemoglobin Concentration in Blood was measured with **HumaMeter Hb**\textsuperscript{Plus} made by HUMAN Gesellschaft für Biochemica und Diagnostica mbH, Max-Planck-Ring 21 · 65205 Wiesbaden, Germany.

5. **Collection of Data**

Data of the different variables was collected with the help of specific tool before and after the supplementation of Ashwagandha with following methods:

a) **Procedure of measuring Maximal Oxygen Consumption Capacity (VO\textsubscript{2max}):**

Cooper 12 minute run fitness test was developed by Dr Ken Cooper in 1968 initially used to estimate the VO\textsubscript{2max} of military personnel. Dr. Cooper discovered that there was a high correlation between a person's VO\textsubscript{2max} value and the distance they can run or walk.

**Testing Procedure**

The subjects were explain about the test that they are required to run as fast as they can and try to cover maximum distance in the 400m track in 12 minutes. The subjects were divided into four groups of 12 each randomly. They were given a time of 10 minutes for warming up before the commencement of the test. At the command “On your marks - GO”, the subject started running in the track. They were informed about the remaining time at the end of each lap (400m) by the investigator. A long whistle was blown as 12 minutes elapsed and distance the subject covered in meters to the nearest 10 metres was recorded for each subject.

**Calculation of VO\textsubscript{2max}.**

\[
VO_{2max.} = (22.351 \times \text{Distance covered in 12 min. in kilometres}) - 11.288
\]
b) Procedure of measuring Sprint Fatigue Level

Mackenzie B. (2006) 40 metre Multiple Sprint Test was used to find out the level of sprint fatigue in the subjects. To carry out the test 40 metre straight section was marked on the track and cones were placed on the side of both lines so that subject can visualise the line easily. The testing procedure was explained to the subject. All the subjects were given 10 minutes time for warming up. The subject was told to stand on starting line, where one assistant with spot watch was also standing and the investigator was standing on the finishing line (40m apart). Assistant gives the command “GO” and researcher starts the stopwatch standing on the finishing line. The subject sprints the 40 metres as fast as possible. The investigator stops the stopwatch when the subject’s torso crosses the finishing line and records the time. The subject take rest for 30 seconds, then the researcher gave command “GO” now assistant standing on the other line recorded the time. The subject performs 6 x 40m sprints with 30 seconds recover between each sprint assistant and investigator records the time for each of the 40 metre sprints.

Fatigue level is calculated with follows formula:

\[ \text{Fatigue Level} = \text{Total Time for the 6 sprints} - (\text{Fastest Time} \times 6) \]

c) Procedure of measuring Agility

The Illinois Agility Run Test (Getchell 1979) was conducted to find out the development in the agility of the subjects of both groups before, during and after the supplementation of Ashwagandha. The subjects were explained about the way one has to complete the circuit in the form of standardized instructions. The subject requires running the red line route shown in the diagram below as fast as possible. The athlete warms up for 10 minutes.
The subject lies face down on the floor at the “Start” cone. At command “GO” subject jumps to his feet and negotiates the course around the cones following the red line route shown in the diagram to the finish point. Time was noted form start to finish.

d) **Procedure of measuring flexibility:**

Mackenzie B. (2000) *Sit and Reach Test* was conducted to find out the development in the lower back and hamstring flexibility of the subjects of both group before and after the supplementation of Ashwagandha.

The athlete warms up for 10 minutes and then removes their shoes. The investigator secured the ruler to the box top with the tape so that the front edge of the box lines up with the 15cm (6 inches) mark on the ruler and the zero end of the ruler points towards the subject. The subject sits on the floor with their legs fully extended with the bottom of their bare feet against the box. He places one hand on top of the other, slowly bends forward and reaches along
the top of the ruler as far as possible holding the stretch for two seconds. The investigator records the distance reached by the subject’s finger tips (cm). Each subject performs the test three times. Then investigator calculates and records the average of the three distances and uses this value to assess the subject’s performance.

e) Procedure of measuring Core Muscle Strength & Stability:

Brian Mackenzie in 2002 developed Core Muscle Strength and Stability test to determine core strength. The objective of the Core Muscle Strength & Stability Test was to monitor the development of the subject's abdominal and lower back muscles. Points will be allocated for each level reached. TARGET = 100 Points.

**Stage - 1**

The subject warms up for 10 minutes. Then using the mat to support their elbows and arms, assumes the **Start Position** as shown in the picture given below. Once the subject is in the correct position the assistant starts the stopwatch. The athlete is to hold this position for 60 sec. Throughout the test the back, neck and head should be maintained in the posture as per figure below. If the athlete is unable to hold this position then the test is to be stopped.

**Stage 1 Points = 1 on completion level 1 or stage 1 (Sub Total 1)**

![Start Position](image1)

**Stage – 2**

The athlete lifts their right arm off the ground and extends it out in front of them parallel with the ground as shown in the picture given below. The athlete is to hold this position for 15 seconds.

**Stage 2 Points = 3 on completion Level 2 or stage 2 (Sub Total – 4)**

![Stage 2 Position](image2)
Stage – 3
The athlete lifts their left arm off the ground and extends it out in front of them parallel with the ground as shown in the picture given below. The athlete is to hold this position for 15 seconds.
Stage 3 Points = 5 on completion of Level or stage 3 (Sub Total - 9)

Stage – 4
The athlete lifts their right leg off the ground and extends it out in front of them parallel with the ground as shown in the picture given below. The athlete is to hold this position for 15 seconds.
Stage 4 Points = 6 on completion of Level 4 or stage 4 (Sub Total - 15)

Stage – 5
The athlete lifts their left leg off the ground and extends it out in front of them parallel with the ground as shown in the picture given below. The athlete is to hold this position for 15 seconds.
Stage 5 Points = 10 on completion of Level 5 or stage 5 (Sub Total - 25)

Stage – 6
The athlete returns to the Start Position, lifts the left leg and right arm off the ground and extends them out parallel with the ground as shown in the picture given below. The athlete is to hold this position for 15 seconds.
Stage 6 Points = 15 on completion Level 6 or stage 6 (Sub Total - 40)

Stage – 7

The athlete returns to the Start Position, lifts the right leg and left arm off the ground and extends them out parallel with the ground as shown in the picture given below. The athlete is to hold this position for 15 seconds.

Stage 7 Points = 25 on completion Level 7 or stage 7 (Sub Total - 65)

Stage – 8

The athlete returns to the Start Position and he has to hold this position for 30 seconds as shown in the picture given below.

Stage 8 Points = 35 on completion Level 8 or stage 8 (Sub Total - 100)

The investigator records the stage at which the athlete is unable to maintain the correct body position or is unable to continue with the test. Scores are given according to the stages completed.

f) Procedure of measure Haemoglobin Concentration in Blood

A trained technician collected 2 ml. of blood in the morning before the training session. The blood was transported to lab for further analysis with HumaMeter HbPlus made by HUMAN Gesellschaft für Biochemica und Diagnostica mbH, Max-Planck-Ring 21 · 65205 Wiesbaden, Germany.

5. Statistical Techniques Used

The statistical tools are used to convert the quantitative data into qualitative responses, So that it may be easy to make the calculation and this
process is known as quantification of data. The selection of statistical tools depends upon the nature of the data and number of variables included in the investigation. In order to analysis the data in the present study the following statistical techniques were used manually as well as on computer:

a) **Mean:** Arithmetic mean was calculated by adding up all the Observations and dividing the sum by the number of individuals.

\[
(\bar{X}) = \frac{\sum X}{N}
\]

Where \( N \) = Total Number of subjects
\( \sum X \) = Sum of all individual values.

b) **Standard Deviation:** It measures the absolute dispersion of variability. It is calculated by following method.

\[
\text{S.D.} = \sqrt{\frac{\sum x^2 - (\sum x)^2}{n-1}}
\]

Where \( \sum x^2 \) = Sum of squares of the individual values.
\( (\sum x)^2 \) = The square of the sum of the individual values.

c) **Standard Error of Difference (S.E.D.):**

\[
\text{S.E.D.} = \sqrt{\left(\frac{(SD_1)^2}{N_1}\right) + \left(\frac{(SD_2)^2}{N_2}\right)}
\]

Where \( S.D_1 \) = Standard Deviation of First Group.
\( S.D_2 \) = Standard Deviation of Second Group.
\( N_1 \) = Number of Sources in First Group.
\( N_2 \) = Number of Sources in Second Group.

d) **t-Test:** test was applied to determine whether the observation difference between two sample means \( X_1 \) and \( X_2 \) were indicative of real difference or it is due to the sampling error. The t-ratio was calculated with the following formula of t-test:

\[
t = \frac{M_1 - M_2}{\text{SED}}
\]

Where \( M_1 \) = Mean of First Group.
\( M_2 \) = Mean of Second Group.