



**Effects of camel whey protein supplementation  
on some immune organs integrity in heat-  
stressed male mice**

**A THESIS**

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## List of Contents

- Aim of the work .....	(1)
- Introduction.....	(2)
- Literature Review.....	(7)
• 2.1. Oxidative stress and Free Radicals.....	(7)
• 2.2. Antioxidant enzymes.....	(14)
• 2.3. Immune system and cytokines.....	(20)
• 2.4. Inflammatory mediators.....	(22)
• 2.5. Heat Shock Protein (HSP).....	(24)
• 2.6. Nuclear Factor Kappa (NF-KB) pathway.....	(25)
• 2.7. Apoptosis.....	(28)
• 2.8. Testes.....	(39)
- Materials and method.....	(45)
• 3.1. Chemicals and reagents .....	(45)
• 3.2. Animals .....	(46)
• 3.3. Preparation of camel whey protein .....	(46)
• 3.4. Induction of HS and dose of CWP .....	(47)
• 3.5. Body weight and food and water intake .....	(48)
• 3.6. Collection of samples .....	(48)
• 3.7. Hematological determination .....	(49)
• 3.8. ELISA assay for the plasma cytokine profile.....	(49)
• 3.9. Measurement of sperm motility.....	(53)
• 3.10. Histopathological studies.....	(54)
• 3.11. Western blots Analysis.....	(61)
• 3.12. Apoptosis detection using Flow Cytometry.....	(72)
• 3.13. Statistical analysis.....	(73)
- Experimental Results.....	(74)
• 4.1. Effect of HS and CWP on body and testis weights.....	(74)
• 4.2. Effect of HS and CWP on food and water intake.....	(76)
• 4.3. Effect of HS and CWP on haematological parameters.....	(77)
• 4.4. Effect of HS and CWP on inflammation in plasma and PBMC lysate .....	(81)
• 4.5. Effect of HS and CWP on oxidative stress and antioxidants in plasma and testis .....	(85)

- 4.6. Effect of HS and CWP on NF- $\kappa$ B pathway:.....(94)
- 4.7. Effect of HS and CWP on apoptosis.....(97)
- 4.8. Effect of HS and CWP on some immune organs.....(110)
- 4.9. Effect of HS and CWP on HSP.....(139)
- 4.10. Effect of HS and CWP on testis.....(143)

- Discussion .....(161)

- Conclusion.....(181)

- Summary.....(185)

- References.....(188)

- Arabic summary

## List of Tables

<b>No. of Table</b>	<b>No. of Page</b>
<b>Table 1: Statistical analysis shows the differences among groups regarding haematological parameters</b>	<b>78</b>
<b>Table 2 : Statistical analysis shows the differences among groups regarding sperm motility.</b>	<b>146</b>
<b>Table 3: Statistical analysis shows the differences among groups regarding all measured numerical parameters</b>	<b>157</b>

## List of Figures

No. of Figure	No. of page
<b>Figure 1: Diagram of CWP health benefits</b>	<b>18</b>
<b>Figure 2: Experimental design and doses</b>	<b>48</b>
<b>Figure 3: Average body weights during the experiment.</b>	<b>74</b>
<b>Figure 4: Testes weight and testis/body weight ratio.</b>	<b>75</b>
<b>Figure 5: Average food and water consumption.</b>	<b>77</b>
<b>Figure 6: Shows the counts of differential WBCs, HCT and HGB in control, HS and HS treated mice with CWP.</b>	<b>79</b>
<b>Figure 7: Shows some haematological parameters in control, HS and HS treated mice with CWP.</b>	<b>80</b>
<b>Figure 8: Plasma level of IL-6.</b>	<b>81</b>
<b>Figure 9 : Plasma level of IL-1<math>\beta</math>.</b>	<b>82</b>
<b>Figure 10: Plasma level of TNF-<math>\alpha</math>.</b>	<b>83</b>
<b>Figure 11: Plasma level of CRP.</b>	<b>84</b>
<b>Figure12: Shows the expression of ATF-3 of control, HS and HS treated mice with CWP.</b>	<b>85</b>
<b>Figure 13: Plasma level of ROS.</b>	<b>86</b>
<b>Figure 14: Testis level of ROS.</b>	<b>87</b>
<b>Figure 15: Plasma level of TAC.</b>	<b>88</b>
<b>Figure 16: Testis level of catalase.</b>	<b>89</b>
<b>Figure 17: Testis level of MnSOD.</b>	<b>90</b>
<b>Figure 18: Testis level of GSH.</b>	<b>91</b>

<b>Figure 19: Testis level of GSH-Px.</b>	<b>92</b>
<b>Figure 20: Shows expression of Nrf2 in testes of control, HS and HS treated mice with CWP.</b>	<b>93</b>
<b>Figure 21: Shows phosphorylation of AKT of control, HS and HS treated mice with CWP.</b>	<b>95</b>
<b>Figure 22: Shows phosphorylation of I<math>\kappa</math>B-<math>\alpha</math> of control, HS and HS treated mice with CWP.</b>	<b>97</b>
<b>Figure 23: Shows % of apoptotic lymphocytes of control, HS and HS treated mice with CWP.</b>	<b>99</b>
<b>Figure 24: Plasma level of caspase 3.</b>	<b>100</b>
<b>Figure 25: Plasma level of caspase 9.</b>	<b>101</b>
<b>Figure 26: Shows phosphorylation of cytochrome C of control, HS and HS treated mice with CWP.</b>	<b>102</b>
<b>Figure 27: Shows expression of P53 in testes of control, HS and HS treated mice with CWP.</b>	<b>103</b>
<b>Figure 28: Shows expression of Bax and Bim of control, HS and HS treated mice with CWP.</b>	<b>105</b>
<b>Figure 29: Shows expression of Survivin of control, HS and HS treated mice with CWP.</b>	<b>107</b>
<b>Figure 30: Shows expression of Bcl-2 of control, HS and HS treated mice with CWP.</b>	<b>108</b>
<b>Figure 31 : Shows expression of Bcl-2 in testes of control, HS and HS treated mice with CWP.</b>	<b>109</b>
<b>Figure32: Plasma level of IL -2.</b>	<b>110</b>
<b>Figure 33: Plasma level of IL-4</b>	<b>111</b>
<b>Figure34: Photomicrograph of bone marrow section from the control mice</b>	<b>112</b>
<b>Figure 35: Photomicrograph of bone marrow section from the HS mice</b>	<b>112</b>

<b>Figure 51: Photomicrograph of section of HS thymus</b>	<b>128</b>
<b>Figure 52: Photomicrograph of thymus section from HS group</b>	<b>128</b>
<b>Figure 53: Photomicrograph of thymus section from HS group</b>	<b>129</b>
<b>Figure 54: Photomicrograph of section of HS+CWP thymus</b>	<b>129</b>
<b>Figure 55: Photomicrograph of thymus sections from the control, HS, and HS+CWP mice were immunohistochemical stained with anti-CD3</b>	<b>130</b>
<b>Figure 56: Photomicrograph of section of control spleen</b>	<b>132</b>
<b>Figure 57: Photomicrograph of section of HS spleen</b>	<b>133</b>
<b>Figure 58: Photomicrograph of section of HS spleen</b>	<b>133</b>
<b>Figure 59: Photomicrograph of section of HS spleen</b>	<b>134</b>
<b>Figure 60: Photomicrograph of section of HS spleen</b>	<b>134</b>
<b>Figure 61: Photomicrograph of section of HS spleen</b>	<b>135</b>
<b>Figure 62: Photomicrograph of section of CWP+HS spleen</b>	<b>136</b>
<b>Figure 63: Photomicrograph of spleen sections from the control, HS, and HS+CWP mice were immunohistochemical stained with anti-CD3</b>	<b>137</b>
<b>Figure 64: Photomicrograph of spleen sections from the control, HS, and HS+CWP mice were immunohistochemical stained with anti-CD20</b>	<b>138</b>

<b>Figure 36: Photomicrograph of bone marrow section from HS group</b>	<b>113</b>
<b>Figure 37: Photomicrograph of bone marrow section from the HS+CWP mice</b>	<b>113</b>
<b>Figure 38: A semithin section of bone marrow from control mice</b>	<b>114</b>
<b>Figure 39: A semithin section of bone marrow from HS mice</b>	<b>115</b>
<b>Figure 40: A semithin section of bone marrow from HS+CWP mice</b>	<b>115</b>
<b>Figure 41: Electron micrograph of bone marrow of control mice</b>	<b>118</b>
<b>Figure 42: Electron micrograph of bone marrow of control mice</b>	<b>119</b>
<b>Figure 43: Electron micrograph of bone marrow of heat stress (HS) mice</b>	<b>120</b>
<b>Figure 44: Electron micrograph of bone marrow of (HS) mice</b>	<b>121</b>
<b>Figure 45: Electron micrograph of bone marrow of (HS) mice</b>	<b>122</b>
<b>Figure 46: Electron micrograph of bone marrow of HS+CWP mice</b>	<b>123</b>
<b>Figure 47: Electron micrograph of bone marrow of (HS+CWP) mice</b>	<b>124</b>
<b>Figure 48: Electron micrograph of bone marrow of HS+CWP mice</b>	<b>125</b>
<b>Figure 49: Electron micrograph of bone marrow of HS+CWP mice</b>	<b>126</b>
<b>Figure 50: Photomicrograph of section of control thymus</b>	<b>127</b>



<b>Figure 65: Photomicrograph of thymus sections from the control, HS, and HS+CWP mice were immunohistochemical stained with anti-HSP-70</b>	<b>139</b>
<b>Figure 66: Photomicrograph of spleen sections from the control, HS, and HS+CWP mice were immunohistochemical stained with anti-HSP-70</b>	<b>140</b>
<b>Figure 67: Shows expression of HSP-70 of control, HS and HS treated mice with CWP.</b>	<b>141</b>
<b>Figure 68: Shows expression of HSP-90 of control, HS and HS treated mice with CWP.</b>	<b>143</b>
<b>Figure 69: Testis level of testosterone.</b>	<b>144</b>
<b>Figure 70: Testis level of LH.</b>	<b>144</b>
<b>Figure 71: Sperm count mean.</b>	<b>145</b>
<b>Figure 72: Sperm motility.</b>	<b>147</b>
<b>Figure 73: Photomicrograph of section of control testis</b>	<b>148</b>
<b>Figure 74: Photomicrograph of section of HS testis</b>	<b>149</b>
<b>Figure 75: Photomicrograph of section of HS testis</b>	<b>149</b>
<b>Figure 76: Photomicrograph of section of HS testis</b>	<b>150</b>
<b>Figure 77: Photomicrograph of section of HS testis</b>	<b>150</b>
<b>Figure 78: Photomicrograph of section of HS+CWP testis</b>	<b>151</b>
<b>Figure 79: Photomicrograph of testis sections from the control, HS, and HS+CWP mice were immunohistochemical stained with anti-YAP</b>	<b>152</b>
<b>Figure 80: Leydig cells number</b>	<b>153</b>

<b>Figure 81: Shows expression of PPAR-<math>\gamma</math> in testes of control, HS and HS treated mice with CWP.</b>	<b>154</b>
<b>Figure 82: Shows expression of 3<math>\beta</math>-HSD in testes of control, HS and HS treated mice with CWP.</b>	<b>156</b>
<b>Figure 83: Diagram of different Effects of HS and CWP on the body.</b>	<b>184</b>

## Summary

Heat stress occurs when an animal cannot dissipate an adequate quantity of heat, whether it is produced or absorbed by the body, to maintain body thermal balance. This may prompt physiological and behavioral responses, leading to physiological disorders that negatively affect the productive and reproductive performance of farm animals.

In the present study, experimental model of HS, was used to find out the effects of HS on the immune organs and testis, in addition to find out treatment can reduces these effects. The objective of this study is to know the role of CWP to alleviate the harmful effects caused by heat stress in male mice.

Therefore, this study was conducted in order to evaluate the effect of heat stress on the immune and other organs and the role of CWP in the treatment of these negative influences. In this study, 45 male albino mice were purchased from Theodore Bilharz Institute in Cairo were divided into three groups, 15 mice each. The first was used as control and the other two groups were subjected to heat stress temperature of 40.0°C for 2 hr daily for one month; the HS mice in the third group were orally supplemented with CWP (200 mg/kg body weight dissolved in 250 µl distilled water/day for one month) through oral gavage. After the expiration of the treatment, all mice were anesthetized with pentobarbital and dissected for collection of blood samples and organs (spleen, testis, thymus and bone marrow) for biochemical analysis and histological observation.

**The study concluded the following results:**

1- HS mice showed increase in the levels of pro-inflammatory cytokines (IL-6, IL1 $\beta$  and TNF- $\alpha$ ), CRP, caspase-3 and caspase-9, while other cytokines (IL-2, and IL-4) and testosterone showed decrease in comparison with the control group.

2- Also, HS mice showed increase in ROS in blood and testis while TAC and other antioxidants (GSH, GSHPx, MnSOD and catalase) showed decrease.

3- Additionally, HS mice showed decrease in body weight, food consumption, testis weight, sperms count and motility, while increase in water consumption and Leydig cells count.

4- Western blot analysis showed significant increase in the expression of ATF-3, Bax, Bim, cytochrome C, HSP-70, HSP-90, Nrf-2, P53 and 3 $\beta$ -HSD while showed significant decrease in phosphorylation of AKT and I $\kappa$ B- $\alpha$ , Bcl-2, survivin and PPAR- $\gamma$  in blood and testis homogenate.

5- Flow cytometry analysis showed an increase in apoptosis percent of lymphocytes.

6- Treatment of HS mice with CWP results in improvement in all the biochemical changes in the blood and testis, with improvement in histological tissue of testis, spleen, thymus and bone marrow. In addition, CWP restored the expression of ATF-3, AKT, I $\kappa$ B- $\alpha$ , Bax, Bim, Bcl-2, P53, cytochrome C, HSP-70, HSP-90, Nrf-2, P53, survivin, PPAR- $\gamma$  and 3 $\beta$ -HSD in blood and testis.

7- Additionally, CWP improved body and testis weight, sperm count and motility, food and water consumption, Leydig cells count, apoptosis in lymphocytes. It also improved ROS, TAC, CRP, caspase-3, caspase-9, testosterone, inflammatory cytokines and antioxidants parameters.

8- Microscopic examination by light microscope and electron microscope revealed pathological changes in HS mice as follows:

- Appearance of incomplete spermatogenesis in testis.
- Shortage in the constituent cells of the blood cells in the BM.
- EM showed degeneration, pyknosis, apoptosis and necrosis of haematopoietic stem cells in BM.
- Immunohistochemical staining showed increase in HSP-70 and YAP expression in lymphocytes and testis respectively.
- Immunohistochemical staining showed aberrant distribution of CD3+ T cells and CD20+ B cells in the thymus and spleen.
- Additionally, pathological alterations were seen such as necrosis, thrombosis, congestion and lymphocytic depletion in the architecture of the lymphoid organs (bone marrow, thymus, and spleen).

9- In conclusion our obtained results find the ability of CWP to reduce the inflammation, oxidative stress, and immune dysfunction due to HS.