

# Antiimmunotoxic of Black Cumin Seed Oil (*Nigella sativa* Oil) in DMBA (Dimethylbenzanthracene)-Induced Mice

*By akrom*

2  
**Antiimmunotoxic of Black Cumin Seed Oil  
(*Nigella sativa* Oil) in DMBA  
(Dimethylbenzanthracene)-Induced Mice**

Titiek Hidayati and Inayati Habib

Medical and Health Science Faculty of Universitas Muhammadiyah, Yogyakarta, Indonesia  
Email: hidayatifikumy@yahoo.co.id, inaythabib@yahoo.co.id

12  
Akrom  
Pharmacy Faculty of Ahmad Dahlan University, Yogyakarta, Indonesia  
Email: akmaa\_uad@yahoo.co

**Abstract**—A single and repeated doses of DMBA are toxic to immune system. Black cumin seed oil (BCSO) is immunoprotector agent. A study was performed to identify antiimmunotoxicity effects of BCSO on DMBA-induced SD mice. This study was conducted with an experimental design with BCSO administration group and a normal control group. DMBA induction was administered by two methods: a single dose of 15mg/mouse per oral (DMBA15group), and repeated doses of  $10 \times 20\text{mg/kg}$  twice/week for 5 weeks (DMBA20/group). Normal control was a non-DMBA-induced group while diseased groups were DMBA-induced groups, DMBA15 and DMBA20. Treatment groups were DMBA 15 and DMBA 20 which were given 0.25ml/kgBCSO 14 days before and during DMBA induction (DMBA15BCSO and DMBA20BCSO groups. Observation was carried out on peripheral blood, spleen histological description and spleen weight, CD4 and CD4CD25 lymphocyte counts. Results showed that the single and repeated doses of DMBA in SD mice are immunosuppressive and hematotoxic. The administration of 0.25ml/kgbwBCSO can decrease the immunosuppressive and hematotoxic effects of DMBA. The number of leukocyte and CD4Th in the treatment groups was higher than the diseased group ( $p < 0.05$ ). Conclusion: BCSO is the antihematotoxic immunoprotector for diseased groups.

**Index Terms**—DMBA, black cumin seed oil (BCSO), immunotoxic, hematotoxic

### I. INTRODUCTION

Dimethylbenz(a)anthracene (DMBA) is one of polycyclic aromatic hydrocarbon (PAHs) that is carcinogenic immunosuppressive. It has been proven that the active metabolite of DMBA, i.e. 3,4, dihydrodiol, 1,2, peroxides are hematotoxic and immunosuppressive, namely, to suppress the erythropoiesis process of bone marrow and to decrease lymphocyte proliferation activity in spleen tissue. It is suspected that repeated exposures of DMBA produce more carcinogenesis and immunotoxic effects than a single exposure of DMBA [1]-[3].

Leucocytes and blood cellular components serve as the main defender against pathogens entering the body. Monocytes and neutrophils are professional phagocytes in the blood that destroy any pathogens interfering the blood. Neutrophils and other granulocyte cells also play a role in inflammatory reactions. The components of blood lymphocytes are responsible in generating adaptive immune response [1], [2], [4].

The Treg lymphocytes of CD4 and CD4CD25 play an important role in cellular adaptive immune response. The Th cells of CD4 play a major role in facilitating the adaptive immune response while the Treg CD4CD25 serve as prevention against allergic reaction and the onset of autoimmunity [4].

The main content of black cumin seed oil involves evaporating such thymoquinone, nigellone and nigelline and non-evaporating oil such as unsaturated fatty oils, i.e. linoleic and linolenic. Unsaturated fatty acids and thymoquinone are powerful antioxidants and potential for immunomodulatory and chemo preventive agents in mammary cancer). The application of *N. sativa* ethanol extract for 14 days in DMBA (7, 12-di-methylbenz (a) anthracene)- induced mice is able to increase TNF- $\alpha$  level and DNA fragmentation [5]-[9]. It has been reported that *N sativa* oil (crude oil fixed) and its active component, i.e. thymoquinone, inhibit cyclooxygenase pathway and 5-lipoxygenase of arachidonic metabolism in the peritoneal cavity leukocytes of mice. However, no anti immunohematotoxic activity assay of BCSO has been conducted in DMBA-induced SD mice with repeated doses. Data availability on the mechanism of BCSO herbal immunomodulatory action is highly important for further development of this natural material [10]-[13].

### II. RESEARCH METHOD

Experimental design was adopted in this research with a control group of DMBA induced female SD mice. Instruments and materials exploited in this research involved corn oil, dimethylbenzanthracene (DMBA), SD mice, cages, minor sets, mice feeding, handsoon,

Manuscript received April 30, 2015; revised July 24, 2015.

chloroform and other consumables; examination kits for lymphocytes of CD4 and CD4CD25 involved FITC CD4 antibody, PE CD25, PBS, RPMI; HE staining kit.

Working procedures:

(1) Examination was conducted on peripheral blood as the parameters of antiimmunotoxicological test on BCSO. Quarantine and acclimation of tested animals were carried out. Sixty SD strain mice aged two weeks were put in plastic cages covered with woven wire. The mice were treated under similar conditions and feeding. Before being exploited for the research, one week adaptation was provided for the mice in the rearing cage. During the quarantine and acclimation periods, feeding and drinking were given to the mice according to the standard. On the sixth day of acclimatization, the tested animals were randomly divided into five groups.

Twenty-five SD strain mice aged three weeks were randomly divided into five groups. Group I as normal group was given with standard feeding and drinking during the test. Group II and group III served as diseased groups. Group II were orally given with a single dose of DMBA in corn oil at 11 mg/mouse Group III were provided with DMBA in corn oil at a dose of 10 x 20 mg / kg orally given, twice a week. Groups IV and V served as treatment groups, given with a pretreatment dose of BCSO 0.25 ml/kgbw for 14 days and induced with 15 mg DMBA/ mouse or 10x20mg/kgbw DMBA, 2 times/week per oral. The examination on peripheral blood, the count and types of leukocytes and erythrocytes was done with spectrophotometers hematoanalyzer as the previous procedure.

(2) Histopathological and spleen weight examination [2], [3], [14].

Isolation and spleen weight examination were carried out based on the procedures specified by the institution. Spleen was taken from the abdominal cavity as soon as peritoneum was opened, after anesthesia with chloroform was conducted on the mice. Following alcohol disinfectant was applied, the abdominal wall was opened with a knife and tweezers to open the peritoneum bag. After the peritoneum was opened and the abdominal content was visible, by using tweezers, the abdominal

organs covering the spleen were removed and the base of the spleen was cut. After the spleen was lifted, then it was cleaned from connective tissues. After totally being clean, then spleen was weighed by using calibrated digital scales. Following the spleen was weighed, the it was cut for histopathological examination and the isolation of spleenocytes.

The histopathological examination of the spleen was performed based on the procedures of the previous researchers, from processing the tissues, hematoxylin & eosin staining and histopathological analysis. The H & E preparation was descriptively analyzed on the changes occurred at the cellular level to identify the changes of spleen tissue description. The histopathological preparation process was done by experts [2], [3].

(3) Examination of CD4 and CD4CD25 Count. The blood collected in vacutainer tubes containing anticoagulant, was ready to be examined by using flowcytometer.

(4) Data Analysis. The statistical analysis on the results of the study used different methods for different data types. Data on the number of peripheral blood cells and th and treg lymphocytes of CD4 and CD4CD25 among the groups and among the periods were analyzed by using ANOVA and Tukey test to analyze the significance differences among the means of the data. The histopathological differences were descriptively analyzed.

### III. RESULTS AND DISCUSSION

#### A. Results

The DMBA dose of 1 × 15 mg/mouse or 10 × 20 mg/kgbw reduced total leukocytes. The decrease of total erythrocytes and platelet was more visible in repeated dosing. The application of BCSO was able to inhibit the decrease of total leukocytes, erythrocytes and platelets, either in a single dose or repeated administration of DMBA. The results of BSO application and DMBA in percentage of peripheral blood component percentage are shown in Table I.

TABLE I. THE PERCENTAGE OF PERIPHERAL BLOOD COMPONENT SD RAT DMBA-INDUCED 1 × 15 MG/MOUSE (DMBA15) AND 10 × 20 MG/KG (DMBA20) WITH OR WITHOUT ADMINISTRATION OF BCSO 0.25 ML/KG

Groups	N	Leukocytes number	Erythrocytes number	Platelets number	Hemoglobin number	Percentage of neutrophils	Percentage of lymphocytes
Normal	5	7.82±3.25	7.66±0.37	930.00±230.65	14.52±0.37	16.36±2.03	83.64±2.03
DMBA15	5	4.02±0.79	7.18±0.28	919.60±237.33	14.36±0.22	15.48±4.56	83.58±3.19
DMBA20	5	4.62±0.82	6.19±0.26	530.00±211.31	12.70±0.39	20.00±3.96	79.80±3.66
DMBA15BCSO	5	7.68±1.98		877.40±110.21	14.20±0.52	15.94±5.60	84.06±5.60
DMBA20BCSO	5	7.46±2.52	7.66±0.37	886.20±177.02	12.68±1.40	16.64±4.52	83.36±4.52

According Schalm's Veterinary Hematology the normal value of lymphocytes is 81.3 ± 5.1%. Based on the average number of lymphocytes, it was identified that repeated exposure to DMBA more reduced the percentage of lymphocytes in the treatment groups. The normal value of monocytes according to Schalm's

Veterinary Hematology is 2.3 ± 1.6%. According to Schalm's veterinary hematology the normal value of neutrophils is 15.4 ± 4.5%. Based on the present study, the number of neutrophils significantly increased from the normal values stated in the literature.

The  $1 \times 15$  mg/mouse or  $10 \times 20$  mg/kgbw DMBA doses provide effects on the reduction of the absolute number of lymphocytes and neutrophils in the peripheral blood of tested animals. The lowest lymphocyte count was indicated in the group receiving repeated doses of DMBA among the groups of tested animals. The application of BCSO was able to inhibit the DMBA exposure-caused decrease of lymphocyte count ( $p < 0.05$ ). The condition of spleen of mice is presented in Table II.

TABLE II. THE SPLEEN WEIGHT, PERCENTAGE OF SPLEEN CULTURE CD4 LYMPHOCYTE, SPLEEN PERCENTAGE OF MICE IN ONE GROUP UNDERGOING EXPANSION IN THE WHITE PULP AREA IN DMBA-INDUCED SD MICE

Groups (n=5)	Mean spleen weight (mg)	Σ Spleen	Percentage (%)
Normal	0.24±0.035	4	80
DMBA15	0.16±0.062	1	20
DMBA20	0.23±0.032	1	20
DMBA15BCSO	0.29±0.039	3	60
DMBA20BCSO	0.27±0.035	4	80

The spleen of normal condition was most commonly seen in normal control group. This indicated that the groups did not undergo body mechanism to produce antibodies, and one of which was seen from the microscopic description on the spleen characterized by the widespread areas of white pulp because of the absence of lymphocyte cell growth. Spleen undergoing the expansion showed active germinal center, which was characterized by increasing number of lymphocytes [2], [3], [13], [15].

Based on the histopathologic description, in general it was shown that the administration of BCSO affected the immune activity in the germinal center of the white pulp. In the present study, no significant increase in spleen weight was detected. According to the theory, the spleen weight will increase when infection and immune activity occur. In general, the result showed that the BCSO application with the doses of 0.25ml/kgbw/day was the dose showing the greatest expansion of the white pulp characterized by the higher percentages of the spleen undergoing expansion in the area of white pulp [7]-[9].

Total lymphocytes of CD4 and CD4CD25 in the spleen of DMBA-induced SD mice have been examined. The effects of DMBA administration of the higher doses of  $1 \times 15$  mg/mouse and the lower repeated doses of  $10 \times 20$  mg/kgbw in SD mice on the CD4 percentages are shown in Table III.

TABLE III. CD4TH AND CD4CD25 TREG COUNT IN 5 KIND GROUPS

Groups (n=5)	CD4 account	CD4CD25 account
Normal	30.20±5.7	2.10±0.50
DMBA15	21.37±1.5	1.23±0.02
DMBA20	23.29±4.2	1.24±0.06
DMBA15BCSO	26.01±3.5	6.69±0.30
DMBA20BCSO	32.92±6.3	4.57±1.32

The DMBA dose of  $1 \times 15$  mg/mouse or  $10 \times 20$  mg/kgbw generally suppressed total CD4 of spleen lymphocyte cultures ( $P > 0.05$ ). The BCSO application was able to suppress the decrease in the CD4 percentage.

The effects of DMBA administration at the higher doses of  $1 \times 15$  mg/mouse and the lower repeated dose of  $10 \times 20$  mg/kgbw in SD mice on the CD4CD25 percentages were obtained in the study. The DMBA dose of  $1 \times 15$  mg/mouse or  $10 \times 20$  mg/kgbw in general lowered the percentage of CD4CD25 although it was not statistically significant ( $p > 0.05$ ). The administration of BCSO is proved to prevent the decrease in the percentage of CD4CD25 lymphocytes.

### B. Discussion

The regimen of DMBA diol epoxide has been proved immunosuppressive by suppressing the activity of lymphocyte proliferation and inhibits bone marrow hemopoiesis. The lower percentage of CD4 lymphocyte culture and the increasing of CD4CD25 percentage is consistent with the immunosuppressant activity of the DMBA diol epoxide regimen. Gao et al. [3] further has proved that the active DMBA regimen in addition to suppress lymphocyte proliferation activity also inhibits the differentiation and promotes apoptosis [3], [11], hence, it may explain the phenomenon identified in this research [3]. DMBA diol epoxide active regimen can suppress bone marrow hemopoiesis process resulting in inhibited formation of blood cells [1]-[3], [10], [11]. This is consistent with the results of studies in which the group with single or repeated exposures to DMBA show a lower total leukocytes and lymphocytes compared to the normal one. The repeated exposure to DMBA produces more severe effect on the process of bone marrow hemopoiesis than the single exposure [5], [10], [16].

Black cummin oil contains aromatic oils, trace elements, enzymes, fatty acids, vitamins and minerals, including omega 3 and omega 6. Nigellone is thymoquinone form of a polymer that has the ability to inhibit the enzyme cyclooxygenase and arachidonic lipooxygenase metabolism. Lipooxygenase catalyzes the formation of leukotriene from arachidonic acid, which serves as an inflammatory and allergic mediator. Thymoquinone has also antioxidant, anti-infective and antihistamine effects. In addition, the active ingredient of black cummin also stimulates the immune system [6]-[8].

T helper cell (CD4Th) serves to recognize the presence of antigens and regulate immune responses. The CD4Th0 lymphocytes activated by the presence of the antigen will differentiate into T lymphocytes CD4Th1. Cytokines produced by CD4Th1 lymphocytes can increase the effectiveness of effectors, TCD8 lymphocytes, NK cells and macrophages. In contrast to T lymphocytes CD4Th1/th2 serving as a regulator of specific cellular immune response, T cells of CD4CD25 are known as Tregulator cell (Treg) to activate the auto tolerance to self and hence self-destruction is prevented. In addition, the increasing percentage of CD4CD25 may prevent autoimmune reaction [4], [17].

## IV. CONCLUSION

The result of this research indicates that exposure to DMBA has been proved to reduce the number of leukocytes, particularly lymphocytes, in which the DMBA administration of repeated doses provides a greater immunosuppressive effect compared to the single dose administration. The administration of 0.25 ml/kgbw/day BCSO may decrease the effects of immunosuppressive and hematotoxic of DMBA.

3

## ACKNOWLEDGMENT

First author wish to thank Indonesia Ministry of higher education (Indonesia DIKTI). This work was supported by a 2011 Competitive Grant Program - Improving the Quality of Medical Education (UMY PHK-PKPD) from Indonesia DIKTI.

## REFERENCES

- [1] J. X. Gao, X. Liu, J. Wen, H. Zhang, J. Durbin, Y. Liu, and P. Zheng, "Differentiation of monocytic cell clones into CD8 alpha+ dendritic cells (DC) suggests that monocytes can be direct precursors for both CD8 alpha+ and CD8 alpha- DC in the mouse," *J Immunol.*, vol. 170, no. 12, pp. 5927-5935, 2003.
- [2] J. Gao, F. T. Lauer, S. Dunaway, and S. W. Burchiel, "Cytochrome P450 1B1 is required for 7, 12-dimethylbenz(a)-anthracene (DMBA) induced spleen cell immunotoxicity," *Toxicol Sci.*, vol. 86, no. 1, pp. 68-74, 2005.
- [3] J. Gao, F. T. Lauer, L. A. Mitchell, and S. W. Burchiel, "Microsomal epoxide hydrolase is required for 7, 12-dimethylbenz[a]anthracene(DMBA)-induced immunotoxicity in mice," *Toxicol Sci.*, vol. 98, no. 1, pp. 137-144, 2007.
- [4] M. L. Salem and M. S. Hossain, "Protective effect of black seed oil from *Nigella sativa* against murine cytomegalovirus infection," *Int. J. Pharmacol.*, vol. 22, no. 9, pp. 729-740, 2000.
- [5] T. Shimada, Y. Oda, E. M. J. Gillam, P. Guengerich, and K. Inoue, "Metabolic activation of polycyclic aromatic hydrocarbon and other carcinogen by cytochromes P450 1A1 and P450 1B1 allelic variants and other human cytochromes P450 in salmonella typhimurium NM 2009," *Drug Metabolism and Disposition*, vol. 29, no. 9, pp. 1176-1181, 2001.
- [6] B. Nickavar, F. Mojab, K. Javidnia, and M. A. Amoli, "Chemical composition of the fixed and volatile oils of *Nigella sativa* L. from Iran," *J. Naturforsch.*, vol. 58, no. 9-10, pp. 629-631, 2003.
- [7] M. A. Randhawa and M. S. Al-Ghamdi, "A review of the pharmacotherapeutic effects of *Nigella sativa*," *Pakistan J. Med. Res.*, vol. 41, no. 2, 2002.
- [8] A. El-Kadi and O. Kandil, "Effect of *Nigella sativa* (the black seed) on immunity," *Bull Islamic Med.*, vol. 4, pp. 344-348, 1986.
- [9] O. A. Badary, M. F. Abd-Ellah, M. A. El-Mahdy, S. A. Salama, and F. M. Hamada, "Anticlastogenic activity of thymoquinone against benzo(a)pyrene in mice," *Food Chem Toxicol.*, vol. 45, no. 1, pp. 88-92, 2007.
- [10] T. Shimada, "Xenobiotic - metabolizing enzymes involved in activation and detoxification of carcinogenic polycyclic aromatic hydrocarbon," *Drug. Metab Pharmacocinet.*, vol. 27, no. 4, pp. 257-276, 2006.
- [11] E. Hodgson, "In vitro human phase I metabolism of xenobiotics I: Pesticides and related chemicals used in agriculture and public health, September 2001," *J Biochem Mol Toxicol.*, vol. 15, no. 6, pp. 296-299, 2001.
- [12] A. Haq, P. L. Lobo, M. Al Tufail, N. R. Rama, and S. T. Al Sedairy, "Immunomodulatory effect of *Nigella sativa* proteins fractionated by ion exchange chromatography," *Int. J. Immunopharmacol.*, vol. 21, no. 4, pp. 283-295, 1999.
- [13] M. S. Al Ghamdi, "The anti-inflammatory, analgesic and antipyretic activity of *Nigella sativa*," *J Ethnopharmacol.*, vol. 76, no. 1, pp. 45-48, 2002.
- [14] J. Gao, L. A. Mitchell, F. T. Lauer, and S. W. Burchiel, "p53 and ATM /ATR Regulate 7, 12-Dimethylbenz[a] anthracene-induced immunosuppression," *Mol Pharmacol.*, vol. 73, no. 1, 2008.
- [15] S. S. Iddalmadeniya, M. L. Thabrew, S. M. D. N. Wickramasinghe, N. Ratnatunge, and M. G. Thammitiyagodage, "A long-term investigation of the anti-hepatocarcinogenic potential of an indigenous medicine comprised of *Nigella sativa*, *Hemidesmus indicus* and *Smilax gabra*," *J. Carcinog.*, vol. 8, no. 1, pp. 6, 2006.
- [16] T. M. Finlay, P. Jayanth, S. R. Amith, A. Gilmour, C. Guzzo, K. Gee, et al., "Thymoquinone from nutraceutical black cumin oil activates Neu4 sialidase in live macrophage, dendritic, and normal and type I sialidosis human fibroblast cells via GPCR Galphai proteins and matrix metalloproteinase-9," *Glycoconj J.*, vol. 27, no. 3, pp. 329-348, 2010.
- [17] R. C. Van der veen, "Nitric oxide and T helper cell immunity," *International Immunopharmacology*, vol. 1, pp. 1491-500, 2001.



**Titiek Hidayati** was born in Yogyakarta. She received her Doctor/Ph. D degree, and M. Kes in the field of epidemiology at the Medical Faculty, Gadjah Mada University, Yogyakarta, Indonesia. She is a lecture at the Department of Epidemiology, Family Medicine and Public Health, in the University Muhammadiyah Yogyakarta. Her research interests include epidemiology, environmental health, tobacco research and non-communicable diseases.

# Antiimmunotoxic of Black Cumin Seed Oil (Nigella sativa Oil) in DMBA (Dimethylbenzanthracene)-Induced Mice

ORIGINALITY REPORT

8%

SIMILARITY INDEX

PRIMARY SOURCES

- |   |                                                                                                                                                                                                                                                                                                                                                                                                       |                 |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1 | <a href="http://tutcris.tut.fi">tutcris.tut.fi</a><br>Internet                                                                                                                                                                                                                                                                                                                                        | 48 words — 2%   |
| 2 | <a href="http://www.iccea.net">www.iccea.net</a><br>Internet                                                                                                                                                                                                                                                                                                                                          | 26 words — 1%   |
| 3 | <a href="http://www.ijbbb.org">www.ijbbb.org</a><br>Internet                                                                                                                                                                                                                                                                                                                                          | 22 words — 1%   |
| 4 | Encyclopedia of Immunotoxicology, 2016.<br>Crossref                                                                                                                                                                                                                                                                                                                                                   | 21 words — 1%   |
| 5 | Anusree, S.S., V.M. Nisha, A. Priyanka, and K.G. Raghu. "Insulin resistance by TNF- $\alpha$ is associated with mitochondrial dysfunction in 3T3-L1 adipocytes and is ameliorated by puniceic acid, a PPAR $\gamma$ agonist", Molecular and Cellular Endocrinology, 2015.<br>Crossref                                                                                                                 | 20 words — 1%   |
| 6 | Weber, Elton Luiz Schmidt, Ernani Luís Rhoden, Ewerton Nunes Morais, Cláudio Galeano Zettler, Brenda Oliveira Alberto, Cristiano Diesel, Fabrício Scapini, and Lisiane Piekala. "The Role of Antibiotic Prophylaxis With Sodium Ceftriaxone to Prevent Bacterial Translocation Associated With Hypovolemic Shock: An Experimental Study in Rats", Journal of Investigative Surgery, 2004.<br>Crossref | 12 words — < 1% |
| 7 | <a href="http://jn.nutrition.org">jn.nutrition.org</a><br>Internet                                                                                                                                                                                                                                                                                                                                    | 11 words — < 1% |

- 
- 8 Kumar, Prasant Ranawade, Ayush V. Kumar,. "Potential probiotic Escherichia coli 16 harboring the Vitreoscilla hemoglobin gene improves gastroin", BioMed Research International, Annual 2014 Issue  
Publications 10 words — < 1%
- 
- 9 Alireza Ghannadi. "An Investigation of the Analgesic and Anti-Inflammatory Effects of *Nigella sativa* Seed Polyphenols", Journal of Medicinal Food, 12/2005  
Crossref 10 words — < 1%
- 
- 10 Elsayed Salim. "Chemopreventive Potential of Volatile Oil From Black Cumin (*Nigella sativa* L.) Seeds Against Rat Colon Carcinogenesis", Nutrition and Cancer, 03/01/2003  
Crossref 9 words — < 1%
- 
- 11 "Toxicological Profile for Mirex and Chlordecone", ATSDR s Toxicological Profiles Web Version, 2002.  
Crossref 9 words — < 1%
- 
- 12 [www.globalresearchonline.net](http://www.globalresearchonline.net)  
Internet 9 words — < 1%
- 
- 13 [www.pmrc.gov.pk](http://www.pmrc.gov.pk)  
Internet 8 words — < 1%

---

EXCLUDE QUOTES OFF  
EXCLUDE BIBLIOGRAPHY ON

EXCLUDE MATCHES OFF