**[Potential Health Benefits of Dark Roast Coffee on DNA]**

Author: Andy T. Tran  
Major: Biological Sciences  
Department of Microbiology and Molecular Genetics, Oklahoma State University, Stillwater, OK 74078, USA

**Key Words:**

Dark roast coffee, DNA strand breakage, protective enzymes

**The purpose of this study is to analyze the health benefits of dark roast coffee. This is done by having a blind study of 50 women and 50 men who are presumed to be healthy. Dark roast coffee is used as the experimental group and water as the control group. The men and women are randomly selected to be in these groups and are classified by gender and their BMI or body mass index. The experiment went on for two sessions of four weeks each. The first session involved an intake of 500ml of water every day without any beverages or products that contain caffeine for both experimental and control groups. The second session involved the experimental group drinking 500ml of freshly made dark roast coffee while the control group drank 500ml of water. Blood was taken from each group after the end of the first and second sessions then examined through single-cell gel electrophoresis to check for the amounts of DNA strand breakage. The results revealed that drinking dark roast coffee can potentially lead to less DNA damage in both genders [1]. Open problems in this field of research is finding the accuracy in current methods of measuring DNA strand breakage and defining how potent the beneficial effects of roast coffee are.**

**Introduction**

DNA integrity is a crucial factor in preventing disorders. These disorders can range from diabetes, cardiovascular diseases, or even cancers [1]. That is why it is so important to find ways of maintaining our DNA’s integrity. Previous studies have hinted that coffee has beneficial effects that can preserve DNA. This is believed to be done through the antioxidant properties that coffee has. For example, Nrf2 in particular is an element that binds to antioxidants and when this occurs the cells that code for Phase II detoxifying enzymes are activated as well. This in turn leads to an increase in the expression of protective enzymes such as glutathione-S-transferase and haeme oxygenase [1]. Alkylpyridinium which is a degradation product of trigonelline through the process of roasting coffee is found to have the largest impact on inducing Nrf2. Catechol and caffeic acid were shown to have similar effects on Nrf2 but not as prevalent as Alkylpyridinium, all of which are constituents of dark roast coffee [1].

**Recent Progress**

Two past experiments in particular gave rise to the most recent one I am discussing. The first one involved a group of 33 men consuming dark roast coffee daily for four weeks and then having the levels of DNA damage analyzed in white blood cells drawn from each person. Results indicated a significant reduction in DNA strand breakage [2]. The second experiment involved both men and women totaling 84 people. The study used two different coffee blends rather than just dark roast coffee and did not have a water control group. With this cross-over design the results were observed by comparing the levels of DNA strand breakage before consumption of the coffee blends and afterwards as well. Unfortunately a carry-over effect was indicated after analyzing the statistical results. This is defined as an effect that causes a given experimental condition to be “carried over” into a different condition [3]. This led to only the preliminary findings being further analyzed but was still verified nonetheless by conducting another test with 90 male volunteers consuming dark roast coffee in a randomized controlled study. The results indicated dark roast coffee decreases the amounts of spontaneous DNA strand breakage [4].

The current study at hand has improved its design from its predecessors by creating a parallel design that involves not only just men and women but a water consuming control group as well. It is also a randomized controlled study that is single-blind and has an intervention trial. Volunteers of 50 men and 50 women who are in good health are taken from the Central European population and then distributed into two groups according to their body mass index [1]. This was done to avoid a disproportion of BMI among the volunteers. After the BMI distribution, volunteers from each group were assigned randomly to the experimental and control group. The requirements for the participants in this study was to be between the ages of 19 to 50, have a body mass index of 19 to 32kg/m2, drinks coffee often, be a non-smoker, and a non-vegetarian. Those who were excluded were those who consumed high alcohol levels, were of high fitness performance, pregnant, had any type of disorders or diseases, and those taking any pharmaceutical prescriptions or food supplements [1]. Blood was drawn from each volunteer before beginning the experiment.

For the first four weeks the participants were not allowed to consume any caffeine-containing beverages or products. 500ml of water, which was divided up into four cups of 125ml, was consumed daily during this period. After the preconditioning period was over, a blood and urine sample was taken along with a 7-day food intake record of all participants. Next, an intervention period went on for another four weeks where the control group consumed 500ml of water daily in the same fashion with no caffeine containing beverages or products while the experimental group consumed 500ml of freshly brewed dark roast coffee daily. No excess caffeine or coffee products were allowed during this trial. At the end of the trial, blood and urine samples were taken as well as a record of a 7-day food intake. Health checks and pregnancy tests were also taken at the end of both the preconditioning and intervention periods to insure continuity [1].

After each trial, the blood of each participant that had been drawn was analyzed for DNA strand breakage through comet assay. Through this method, the tail intensity or TI percentage expressed could be used to measure the amount of DNA strand breakage. The Mean ± standard deviation of the control group was 0.92 ± 0.34% TI at the start of the study and 0.92 ± 0.33% TI after the intervention trial using the Wilcoxon rank sum test [1]. Mean ± standard deviation of the experimental group was 1.05 ± 0.36% at the start of the study and 0.83 ± 0.28% TI after the intervention trial, revealing a significant decrease of − 0.23 ± 0.46% TI when compared to the control group using the paired t-test. 5% significance level was used for all statistical calculations [1]. These results showed that DNA strand breakage was higher before the beginning of the intervention trial for the experimental group compared to after the intervention trial. This rejected the null hypothesis that the experimental group and control group would not have a significant difference among one another. It should also be noted that the amount of DNA damage recorded was not significantly different among men and women in both experimental and control groups [1].

**Discussion**

The results of this study and previous ones before it continue to support that dark roast coffee has possible benefits towards the health of those who consume it. This includes over 100 studies that were reviewed and compiled together into one “umbrella review” [5]. All of which showed lower cardiovascular diseases and cancer rates as well as many other diseases. The only harmful effect was in a previous study mentioned in the umbrella review where higher rates of an early birth, loss of pregnancy, or low birth weight was observed in pregnant women [5]. Considering the fact that DNA strand breakage decreased by approximately 15% after consuming coffee for the intervention trial compared to the control group of this current study indicates that it could have clinical importance. This study did not isolate the peripheral mononuclear cells like past studies and used unprocessed whole blood instead. The best method of obtaining blood samples to analyze without creating any additional DNA breakage is still being investigated [6,7]. Accuracy is a key role in any study and this is definitely a possible issue with this field of study in particular. Analyzing whole blood could create an under-estimation of DNA damage because it may not be as precise as isolating mononuclear cells. It should be noted that the process of isolating mononuclear cells is through density gradient centrifugation and washing which could possibly cause more DNA damage leading to an over-estimation instead [6,7].

The main factors that I would personally suggest improving on would be a larger sample size and a longer extension to observe the long-time effects. The focus of this study was the inducement of Nrf2 and EpRE elements that initiate oxidative stress defense genes [1]. It is recommended to look into the inhibition of NF-kB through roast coffee constituents. This results in anti-inflammatory activity and has been observed in other coffee-related studies [8]. Another question that remains is whether the degree of roasting affects the level of DNA protective benefits. This study only used freshly brewed dark roast coffee blend. Other types of roasts should be further investigated to learn more about coffee and its potential health benefits. It would also be good to observe which one performs best. After reviewing this study I find it to be valid in its results that coffee does have potential DNA protective effects and look forward to any future progress made in relation to such. I believe it would be great if this information could be used for clinical use. A key factor would first be finding how potent the components of coffee are and if positive results are found the next step would be to isolate the components that initiate the health benefits mentioned. As of for now, finding ways to include roast coffee into a daily diet could definitely be a benefit for many people.

**References**

1. Schipp, D., Tulinska, J., Sustrova, M. et al. (2018) “Consumption of a dark roast coffee blend reduces DNA damage in humans:results from a 4-week randomized controlled study” European Journal of Nutrition. <https://doi.org/10.1007/s00394-018-1863-2>
2. Bakuradze T, Boehm N, Janzowski C, Lang R, Hofmann T, Stockis J-P, Albert FW, Stiebitz H, Bytof G, Lantz I, Baum M, Eisenbrand G (2011) “Antioxidant-rich coffee reduces DNA damage, elevates glutathione status and contributes to weight control: results from an intervention study.” Mol Nutr Food Res 55(5):793–797. <https://doi.org/10.1002/mnfr.201100093>
3. Dieminger N, Hofmann T, Winkler S, Hassmann U, Marko D, Schipp D, Raedle J, Bytof G, Lantz I, Stiebitz H, Richling E (2014) “Four-week coffee consumption affects energy intake, satiety regulation, body fat, and protects DNA integrity.” Food Res Int 63(Part C):420–427. https ://doi.org/10.1016/j.foodres.2014.05.032
4. Bakuradze T, Lang R, Hofmann T, Eisenbrand G, Schipp D, Galan J, Richling E (2015) “Consumption of a dark roast coffee decreases the level of spontaneous DNA strand breaks: a randomized controlled trial.” Eur J Nutr 54:149–156. <https://doi.org/10.1007/s00394-014-0696-x>
5. Poole R, Kennedy OJ, Roderick P, Fallowfield JA, Hayes PC, Parkes J (2017) “Coffee consumption and health: umbrella review of meta-analyses of multiple health outcomes.” BMJ 359:j5024. <https://doi.org/10.1136/bmj.j5024>
6. Bakuradze T, Boehm N, Janzowski C, Lang R, Hofmann T, Stockis J-P, Albert FW, Stiebitz H, Bytof G, Lantz I, Baum M, Eisenbrand G (2011) “Antioxidant-rich coffee reduces DNA damage, elevates glutathione status and contributes to weight control: results from an intervention study.” Mol Nutr Food Res 55(5):793–797. <https://doi.org/10.1002/mnfr.201100093>
7. Bakuradze T, Lang R, Hofmann T, Eisenbrand G, Schipp D, Galan J, Richling E (2015) “Consumption of a dark roast coffee decreases the level of spontaneous DNA strand breaks: a randomized controlled trial.” Eur J Nutr 54:149–156. <https://doi.org/10.1007/s00394-014-0696-x>
8. Paur I, Balstad TR, Blomhoff R (2010) “Degree of roasting is the main determinant of the effect of coffee on NF-kB and EpRE.” J Free Radic Biol Med 48(9):1218–1227. [https://doi.org/10.1016/j.freer adbio med.2010.02.005](https://doi.org/10.1016/j.freer%20adbio%20med.2010.02.005)