ORIGINAL RESEARCH ARTICLE

COFFEE POWDER: THE FUNCTIONAL FOOD AGAINST SENESCENCE VIA INHIBTION OF GLYCATIVE AND OXIDATIVE STRESS

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ABSTRACT

Objective: The natural process of ageing may enhance under certain conditions leading to an early decrease in the quality of living. Among others, the harmful phenomenon like glycation and oxidative stress primarily underlie aforementioned scenario. In this situation, the medicinal foods are extremely beneficial to combat the harmful mechanisms.

Methodology: To investigate the anti-ageing property of 5 common dietary substances i.e. coffee powder, coconut water, lemon juice, orange juice and grape fruit juice was the objective of study using anti-glycation and anti-oxidant assays. The Venn diagram (50% inhibition threshold) was used to identify the most effective test substance against ageing.

Results: Our experiments showed that coffee powder was the best glycation inhibitor (92%) followed by coconut water (72%) at the dose of 1 mg/ml. Rest of the test substances did not produce remarkable inhibition. In case of anti-oxidant assay, the grape fruit juice showed the maximum inhibition (91%) followed by coffee powder (75%), orange juice (52%), coconut water (46%) and lemon juice (26%). Among all these test substances, only coffee powder was able to acquire central position in the Venn diagram.

Conclusion: The coffee powder demonstrated the best activity against glycative and oxidative stress. Hence, its continuous use shall be recommended for offering protecting against senescence and associated morbidities.

Keywords: Glycation; Oxidative stress; Coffee powder; Functional food

INTRODUCTION

The phenomenon of growing old is physiological and occurs at a particular pace. However, it is happening at the more faster pace these days as suggested by estimates that the number of aged shall cross the young by the year 2050 (Suzman and Beard, 2011). The situation warrants immediate attention of the scientific community to enhance the produce life span. A large number of factors has been attributed to early decline in the life quality (Campisi et al., 2019). Among them, the glycation and oxidative stress are the prominent underlying biochemical reactions. In case of former, the biological garbage accumulates in the body (Sergiev et al., 2015) famous as Advance Glycation End products (AGEs) (Ross, 2015). On the other hand, the later happens because of accumulation of reactive radicals inside the body (Pole et al., 2016). The glycation reaction (also known as Maillard reaction) happens because of the non-enzymatic reaction between carbohydrates and proteins leading to the formation of AGEs after weeks (Goldin et al., 2006). The levels of these AGEs co-relates with learning disorder (Igase and Igase, 2018, Southern et al., 2007), renal insufficiency (Sun et al., 2016) and hepatic disease (Leung et al., 2016). It is worth noting that the complications associated diabetes mellitus are primarily because of process of glycation (Ramasamy et al., 2005). As a result of this deleterious phenomenon, the stress appeared in the body is termed as glycative stress

(Yonei et al., 2020).

It is established fact that the AGEs plays an instrumental role in numerous of pathologies. However, no medicine is currently available in clinics to combat this phenomenon. Search of literature revealed that few blockers (Reddy and Beyaz, 2006), which also includes the famous aminoguanidine. However, none of these blockers got approval because of limitation in their safety and efficacy (Campbell, 1996, Thornalley, 2003). Keeping this into account, there is immense need to look for glycation inhibitors. The concept of functional foods can be very handy in this scenario. These are the foods which along with the nutrition value also holds the medicinal value. Hippocrates also believed in this concept as indicated by his words i.e. let food be thy medicine and medicine be thy food (Hasler, 2002). The benefits of using the medicinal value of food is that they are easily available, economical and has strong patient compliance. Most importantly, there is no prior need of costly and lengthy safety studies before its use. Keeping this in view, the present study assess the anti-ageing ability of few frequently used food substances.

MATERIALS & METHODS

Selection of functional food
The five most frequently used food substances i.e. coffee powder, coconut water, lemon juice, orange juice and grape fruit juice were freeze dried to be used in the present study.

Anti-glycation Assay
The assay involved bovine serum albumin (BSA) and fructose as described earlier (Khan et al., 2017). The BSA (10 mg/ml) and fructose (50mM) were mingles and heated (60 ˚C) for 24 hours for the glycation to occur. The aforementioned reaction mixture contains the selected freeze dried functional foods at 1mg/ml. The formation of AGEs was measured using intrinsic fluorescence at Excitation and emission lambda of 340 and 435 nm respectively.

Anti-oxidant Assay
The ability of test substance to scavenge free radical was assessed using DPPH (1-1diphenyl-2-picryl-hydrazyl) assay as described earlier (Shen et al., 2010). In brief, the DPPH (0.1 mM in methanol) was mixed with test substances (working strength = 1 mg/ml), shaken and left at ambient temperature for thirty minutes followed by measurement of absorbance (517 nm). The assay was performed in triplicate.

Venn Diagram
In order to identify the most effective test substance, the Venn diagram was used at threshold of fifty percent inhibition.

Data analysis
The data is shown as mean ± SEM of percent change in triplicate set of study.

RESULTS

The results obtained in various assays are as follow:
Glycation inhibition assay
Among various food substances tested in present study, the coffee powder has shown the maximum inhibition of 92% followed by coconut water (79%) as presented in Table-1. Rest of the food substances did not caused noticeable inhibition.

Table-1 Effect of various dietary substances on glycation inhibition

S. No.	Functional Food	Scientific name	AGE Inhibition (%)
1	Coffee powder	*Coffea*	92
2	Coconut water	*Cocos nucifera*	79
3	Lemon juice	*Citrus limon*	9
4	Orange juice	*Citrus sinensis*	5
5	Grape fruit juice	*Citrus paradisi*	0
Aminoguanidine (3 mM; positive control)			76

Antioxidant Assay

The dietary substances showed the inhibition in following orders: grape fruit juice > coffee powder > orange juice > coconut water > lemon juice as shown in Table-2.

Table-2 Effect of various dietary substance on free radical scavenging

S. No.	Functional Food	Scientific name	Free radical scavenge (%)
1	Coffee powder	*Coffea*	75
2	Coconut water	*Cocos nucifera*	46
3	Lemon juice	*Citrus limon*	26
4	Orange juice	*Citrus sinensis*	52
5	Grape fruit juice	*Citrus paradisi*	91
Ascorbic acid (1 mM; Positive control)			86

Venn Diagram

Among dietary substances tested in present study, only coffee powder was able to acquire the central position in the Venn diagram with fifty percent inhibition in both assays (Figure-1).

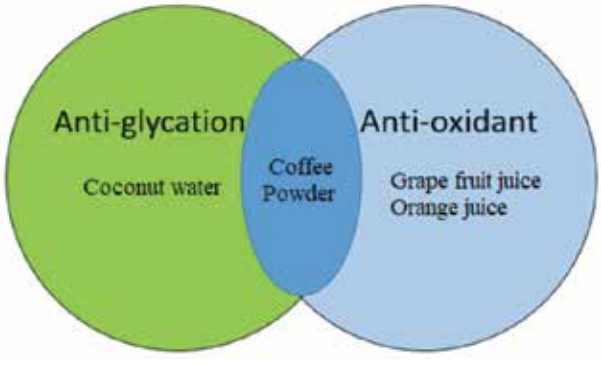

Figure-1 Venn diagram at Inhibition Threshold of 50 percent

DISCUSSION

The ageing or senescence presents itself as the decline in bodily function along with the surfacing of certain ailments. Certain disorders are also known to enhance the pace of ageing. The glycation and oxidative stress primarily underlies the aforementioned decline and are also the promising pharmacological targets for associated conditions. The current study aims to identify the functional food with the ability to obstacle the deleterious phenomenon like glycation and oxidative stress thereby increasing the productive life span.

Functional foods are the dietary substances which along with the nutritional role also provide the medicinal benefits. The food has been known to play a pivotal role in the pathogenesis and cure of disorders. However, the absence of scientific rationale in favor of their consumption for medicinal use has been considered as the major impediment in general acceptability of this concept. This gap is continuously being filled by the researchers working in the field of nutritional pharmacology thereby leading to the emergence of the field of nutraceuticals. The adherence to medication and patient compliance are much better as compared to the modern system of medicines. Therefore, one can observe an increasing trend that the nutrition experts recommending the use of particular food constituent(s) (Solfrizzi et al., 1999),

raw food (Berr et al., 2009) or food plan (Yannakoulia et al., 2015). In present study, the obtained data exhibited that coffee powder was best in inhibiting (92%) the harmful process of glycation (Table-1). Search of literature revealed that coffee has an anti-ageing effect (Takahashi and Ishigami, 2017), especially on psychomotor and cognitive functions (Shukitt-Hale et al., 2013). These effects can be attributed to anti-glycation activity reported in present study.

The senescence is extremely complex condition and multiple pathophysiological mechanisms are involved including oxidative stress (Srinivasan, 2014). Our data exhibited grape fruit juice to be the best scavenger of free radical followed by coffee powder (Table-2). Considering the heterogeneous nature of senescence, the Venn diagram was used to identify the food with fifty percent inhibition of both glycation and oxidative stress. In this context, the only coffee powder was able to acquire the central positive in Venn diagram (Figure-1). Hence, it manifest itself as an importance dietary substances endowed with ability to ameliorate two pathologically important pathways i.e. glycation and oxidation.

To conclude, our data presents coffee powder as a remarkable inhibitor of glycation and oxidative stress. Hence, it daily consumption is suggested in order to increase the quality of life over time and protection against diseases attributed to the ageing.

REFERENCES

BERR, C., PORTET, F., CARRIERE, I., AKBARALY, T. N., FEART, C., GOURLET, V., COMBE, N., BARBERGER-GATEAU, P. & RITCHIE, K. 2009. Olive oil and cognition: results from the three-city study. Dementia, 28, 357-364.

CAMPBELL, I. L. 1996. Exacerbation of lymphocytic choriomeningitis in mice treated with the inducible nitric oxide synthase inhibitor aminoguanidine. Journal of neuroimmunology, 71, 31-36.

CAMPISI, J., KAPAHI, P., LITHGOW, G. J., MELOV, S., NEWMAN, J. C. & VERDIN, E. 2019. From discoveries in ageing research to therapeutics for healthy ageing. Nature, 571, 183-192.

GOLDIN, A., BECKMAN, J. A., SCHMIDT, A. M. & CREAGER, M. A. 2006. Advanced glycation end products: sparking the development of diabetic vascular injury. Circulation, 114, 597-605.

HASLER, C. M. 2002. Functional foods: benefits, concerns and challenges—a position paper from the American Council on Science and Health. The Journal of nutrition, 132, 3772-3781.

IGASE, M. & IGASE, K. 2018. Cognitive impairment and glycative stress. Glycative stress research, 5, 45-49.

KHAN, S. A., HAIDER, A., MAHMOOD, W., ROOME, T. & ABBAS, G. 2017. Gamma-linolenic acid ameliorated glycation-induced memory impairment in rats. Pharmaceutical biology, 55, 1817-1823.

LEUNG, C., HERATH, C. B., JIA, Z., ANDRIKOPOULOS, S., BROWN, B. E., DAVIES, M. J., RIVERA, L. R., FURNESS, J. B., FORBES, J. M. & ANGUS, P. W. 2016. Dietary advanced glycation end-products aggravate non-alcoholic fatty liver disease. World journal of gastroenterology, 22, 8026.

POLE, A., DIMRI, M. & DIMRI, G. P. 2016. Oxidative stress, cellular senescence and ageing. AIMS molecular science, 3.

RAMASAMY, R., VANNUCCI, S. J., YAN, S. S. D., HEROLD, K., YAN, S. F. & SCHMIDT, A. M. 2005. Advanced glycation end products and RAGE: a common thread in aging, diabetes, neurodegeneration, and inflammation. Glycobiology, 15, 16R-28R.

REDDY, V. P. & BEYAZ, A. 2006. Inhibitors of the Maillard reaction and AGE breakers as therapeutics for multiple diseases. Drug discovery today, 11, 646-654.

ROSS, S. M. 2015. Sugar-induced aging: the deleterious effects of excess dietary sugar intake. Holistic nursing practice, 29, 114-116.

SERGIEV, P., DONTSOVA, O. & BEREZKIN, G. 2015. Theories of aging: an ever-evolving field. Acta Naturae, 7.

SHEN, Q., ZHANG, B., XU, R., WANG, Y., DING, X. & LI, P. 2010. Antioxidant activity in vitro of the selenium-contained protein from the Se-enriched Bifidobacterium animalis 01. Anaerobe, 16, 380-386.

SHUKITT-HALE, B., MILLER, M. G., CHU, Y.-F., LYLE, B. J. & JOSEPH, J. A. 2013. Coffee, but not caffeine, has positive effects on cognition and psychomotor behavior in aging. Age, 35, 2183-2192.

SOLFRIZZI, V., PANZA, F., TORRES, F., MASTROIANNI, F., DEL PARIGI, A., VENEZIA, A. & CAPURSO, A. 1999. High monounsaturated fatty acids intake protects against age-related cognitive decline. Neurology, 52, 1563-1563.

SOUTHERN, L., WILLIAMS, J. & ESIRI, M. M. 2007. Immunohistochemical study of N-epsilon-carboxymethyl lysine (CML) in human brain: relation to vascular dementia. BMC neurology, 7, 1-8.

SRINIVASAN, K. 2014. Antioxidant potential of spices and their active constituents. Critical reviews in food science nutrition, 54, 352-372.

SUN, H., YUAN, Y. & SUN, Z. 2016. Update on mechanisms of renal tubule injury caused by advanced glycation end products. BioMed research international, 2016.

SUZMAN, R. & BEARD, J. 2011. Global health and ageing. Bethesda, MD: US Department of Health and Human Services. WHO.

TAKAHASHI, K. & ISHIGAMI, A. 2017. Anti-aging effects of coffee. Aging, 9, 1863.

THORNALLEY, P. J. 2003. Use of aminoguanidine (Pimagedine) to prevent the formation of advanced glycation endproducts. Archives of biochemistry biophysics, 419, 31-40.

YANNAKOULIA, M., KONTOGIANNI, M. & SCARMEAS, N. 2015. Cognitive health and Mediterranean diet: just diet or lifestyle pattern? Ageing research reviews, 20, 74-78.

YONEI, Y., YAGI, M. & TAKABE, W. 2020. Stop the "Vicious Cycle" induced by Glycative Stress. Glycative Stress Research, 7, 13-21.