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COMPONENTS OF COFFEE AND THE IMPACT OF COFFEE ON HEALTH-A REVIEW

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ABSTRACT: Coffee is usually consumed because of coffee's unique taste and aroma. Coffee contains different chemical compounds, especially caffeine and chlorogenic acid, the most common coffee compounds. coffee is helpful in various ways to the body. consumption of coffee may help to prevent several chronic diseases, like type 2 diabetes, liver disease, and other disease. There is also evidence that decaffeinated coffee also has many benefits as regular coffee, indicating that besides caffeine, chlorogenic acid that is present in the coffee also helpful for the body. For those who consume modest amounts of coffee, there is some evidence of health benefits and no evidence of health hazards. (3–4 cups per day, or 300–400 mg of caffeine).

Keywords: Coffee, health, caffeine, heart, metabolism, disease, chlorogenic acid, liver, Diabetes.

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INTRODUCTION

There were approximately 151.62 million 60-kilogram bags of robusta coffee produced during the year 2016–17[1], and more than 2.25 billion cups of coffee are consumed daily in the world. [2]. Mostcountries serve coffee and their ways to make coffee .consumption of coffee was extremely low in thetenth century. Ethiopia is where coffee is from. The Yemeni Sufi monks of the 15th century

were the first to learn about the coffee tree. It had spread to the rest of the Middle East, South India, Persia, Turkey, and Northern Africa by the 16th century. Coffee In 2016/17, the production of coffee amounted to about 151.62 million 60 kg then the majority of that quantity being sent to Italy, Europe, Indonesia, and then to America. [3]. Even though coffee was only recently introduced to Europe, it currently plays a vital role in each of our national cultures. The term "coffee" refers to a brewed beverage made from the roasted seeds of a coffee bush. Berries that are processed and dried after reaching maturity contain coffee beans. Coffea Arabica (coffee Arabica) and Coffea canephora are the two primary species (coffee Rustica). They have a long history of production and play a significant part in both the worldwide market and research Major difference between coffee rustic and coffee Arabica is coffee rustic has double the amount of caffeine compared to coffee Arabica. [4] Other compositions of the coffee cherries vary according to the species and the climate and soil conditions. Variations of those parameters affect the compositions of the coffee cherries. The composition of the green coffee beans is changed during the roosting process of that coffee beans. The composition of the beverage will also depend on various brewing techniques like boiling, infusion, filtration, percolation, vaporization under pressure, and instant coffee. [5] coffee includes caffeine and coffee is abundant in polyphenols like chlorogenic acids. The main chlorogenic acid in coffee is 5-caffeoylquinic acid, although other caffeoylquinic, feruloyl quinic, and Di caffeoylquinic acids are present in significant quantities [6].

Components of the coffee:

ALKALOIDS:

Caffeine: -

Caffeine is first extracted from cocoa beans into the purest form in the 1820s by the German Scientist Friedrich Ferdinand Runge. The main sources of caffeine are tea, coffee, cocoa beverages, energy drinks, and others [7] . One normal cup of coffee contains 65 to 120 mg of caffeine [8]. Caffeine is a chemical compound that adsorbs rapidly and completely in humans. 99% of the administered dose was absorbed in about 45 mins. [9,10] Caffeine is mainly absorbed from the small intestine.20% of the caffeine is absorbed by the stomach. [9] caffeine absorption is examined with the help of radiolabelled caffeine. [11,12]. The cytochrome P450 oxidase enzyme system, specifically the CYP1A2 enzyme, breaks down caffeine in the liver into three main metabolites: paraxanthine (84%), theobromine (12%), and theophylline (4%). [13]. The NAT2 enzyme, which can catalyze the transformation of a wide variety of xenobiotics, is also implicated in the clearance of caffeine [14]. When consumed in amounts typical for human consumption, caffeine works primarily as an adenosine receptor antagonist. A1, A2A, A2B, and A3 are the cloned adenosine receptors. While A2A and A2B couple to Gs and promote the generation of cyclic AMP (cAMP), A1 and A3 receptors preferentially couple to Gi proteins and inhibit adenylate cyclase [15]. These receptors are widely

expressed in the human body and have been connected to several physiological and pathological biological processes. Along with inflammatory diseases, ischemia-reperfusion, and neurodegenerative conditions, these include heart rhythm and circulation, lipolysis, renal blood flow, immunological function, sleep regulation, and angiogenesis. [16] Due to its structural similarity to adenosine, caffeine can potently block adenosine's actions on the A2A and A1 receptor subtypes even at the low levels obtained after only one cup of coffee. By inhibiting phosphodiesterase, cyclic nucleotide breakdown can be prevented at twenty times lower doses. A 40-fold increase in concentration is required to inhibit GABAA receptors, whereas a 100-fold increase is required to activate ryanodine receptors, which mobilize intracellular calcium stores [17]. Normal coffee consumption is unlikely to result in these high levels of caffeine in humans [18].

Trigonelline:

Trigonelline, present at concentrations of 1% and 0.7% in dry Arabia and Robusta green coffee, is decomposed on roasting but around 0.2% is still present in roasted Arabica coffee and 1.4 % in dry instant coffee [19,20] Trigonelline is transformed during roasting into nicotinic acid (niacin; vitamin PP), methyl nicotinate, and 3-methylpyridine. [19]. the metabolism of nicotinic acid has been extensively investigated in animals and the following metabolites were found with the unchanged product: nicotinic acid, nicotinamide, N-methyl nicotinamide, N-methyl-2-pyridone-5-carboxamide, N-methyl- 4-pyridine-3-carboxamide, nicotinamide-N-oxide, 6-hydroxy nicotinic acid, 6-hydroxy nicotinamide, and trigonelline. [21,22].

AROMATIC COMPOUNDS:

Chlorogenic acid:

Chlorogenic acids are the esters of caffeic and quinic acids. Amount of the chlorogenic acid depends on the roasting of the coffee beans. Higher roasting time decreases the amount of chlorogenic acid in the coffee beans. 5-caffeoylquinic acid, and 3-caffeoylquinic acid, also called neochlorogenic acid are the most important compounds. The 4-caffeoylquinic isomer is also present as well as 3,4-3,3,5-,4,5- dicaffeoyl and feruloylquinicacid. The feruloyl quinic

acid and Di caffeoylquinic acids content are higher in Robusta than in Arabica coffee beans. [19]. chlorogenic acid in instant dry coffee is 4% to 10% and in roasted coffee 0.2% to 4%. [19].

Caffeic acid: -

Caffeic acid is the precursor of m-hydroxy hippuric acid in human urine [23] where the glycoconjugates of m-hydroxy-coumaric acid and m-coumaric acid seemed to be the main metabolites. Caffeic acid, dihydrocaffeic, ferulic, dihydro ferulic, vanillic, and m-coumaric acids as well as the glycoconjugates of feruloylglycine and vanilloylglycine were identified in urine.[24] the role of intestinal bacteria on caffeic acid metabolism was demonstrated in humans by comparing control subjects with subjects treated with neomycin to suppress their gut flora[25].the specific roles

of different bacteria of the flora in transforming caffeic acid into dihydrocaffeic acid, ferulic acid, dihydro ferulic acid, m hydroxyphenyl propionic acid, vinyl catechol, and ethyl catechol in the host are now known. After the ingestion of 1 g caffeic acid by adult volunteers, only 10% of the dose was recovered, and the highest level of caffeic, vanillic, ferulic, and is ferulic acids were identified and quantified in the urine samples collected in the first 4 hours.[26]

Quinic Acid :

The metabolic formation of an aromatic ring structure from quinic acid was reported before the beginning of this century [24]. hippuric acid was excreted in the urine after oral administration, but its formation was suppressed on parenteral injection of quinic acid in the guinea pig and after neomycin treatment in humans[27]. the same results with neomycin were obtained in the rhesus monkey. The fate of quinic acid was investigated in 22 species of animals including humans where 60% of an oral dose of quinic acid was excreted as hippuric acid [28]. in the rat, the 'aromatization' of quinic acid does not appear to be enhanced upon chronic administration, and ranges from 17-27% and 0.7-2.0% of a 100 mg quinic acid dose were found as urinary hippuric acid and catechol, respectively. Neither protocatechuic acid nor vanillic acid was detected[29]. 'Aromation' by the gut flora of another coffee component, shikimic acid, has also been demonstrated [30] .

Guaiacol :

Guaiacol (2-methoxyphenyl) is a phenolic compound found at concentrations of 2-3 mg/kg and 8-10 mg/kg in Arabica and robusta roasted coffees, respectively [20]. the metabolism of guaiacol has been studied because it is used to esterify drugs such as ibuprofen to improve their gastrointestinal tolerance, and guaiacol glyceryl ether is also used as an expectorant. Two hours after oral administration in humans, the plasma concentrations of guaiacol reached a peak, followed by a plateau explained by delayed gastrointestinal absorption [31]. One major metabolite, beta-(methyoxyphenoxy)lactic acid, has been identified in humans[32].

Eugenol :

Among the phenolic compounds, quantitative findings were reported for isoeugenol (4-propenyl-2-methoxyphenol) and 0.1 mg/kg was found in roasted coffee [20]. Eugenol (4-allyl-2-methoxyphenol), was detected in coffee[19], is used as a food flavor particularly in the form of cloves and also as a fragrance agent. However, its pharmacological and toxicological properties, including its metabolism, were studied and reviewed recently because of its extensive use as a local anesthetic in dentistry[33].

Benzo(a)Pyrene :

Polycyclic aromatic hydrocarbons (PAH), particularly benzo(a)pyrene, have been found in roasted coffee at concentrations of 0.1-4 microgram/kg and below 1 microgram/kg in soluble coffee [19]. however, coffee consumption contributes to less than 0.1% of the total PAH inhaled or ingested from

all sources [20]. Benzo(a)pyrene has been considered a prototype polycyclic hydrocarbon because of its powerful carcinogenic activity and its widespread presence in the environment.

HETEROGENIC COMPOUNDS :

2-Methylfuran

2-methyl furan is a naturally occurring furan found in many foods and detected in green and roasted coffee [19,34]. an in vitro study demonstrated the metabolic activation of 2-methyl furan by the hepatic and pulmonary microsomal system to the reactive metabolite acetyl acrolein (4-oxo-2-pentenal)that binds covalently to microsomal proteins [35].

5-hydroxymethyl-2-furaldehyde

Aldehydes play an important role in the aroma of roasted coffee, and six furanoids have been identified. Furfural is found in quantities ranging from 55-80 mg/kg, 5-methyl furfural from 50-70 mg/kg, 5- hydroxymethyl-2-furfural from 10-35mg/kg, and 2-furyl-acetaldehyde is present at a level of only 0.5 mg/kg.[19,20]. metabolic balance studies in humans discovered

that the excretion of 5-hydroxy-methyl- 2-furoic acid and furan-2,5-dicarboxylic acid was found in urine. furan carboxylic acid is found in roasted coffee at a level of 55-80 mg/kg[19].

Pyridines

Heterocyclic nitrogen and sulfur ring-containing compounds are important for the flavor of coffee. a list of 68 pyrroles, 71 pyrazines, 11 quinoxalines, 4 quinolines, 5 indoles, 24 oxazoles, 26 thiazoles, 32 thiophenes, and 2 dithiolanes was reported. Twelve pyridine derivatives were detected and a concentration of 49 mg/kg pyridine was identified in coffee. [20] pyridine is a breakdown product of trigonelline formed during the roasted process[19].

Maltol

Isomaltol is one of the 111 furans detected in roasted coffee, and it was found in robusta and Arabica coffees at levels of 1.5 and 8 mg/kg. Other heterocyclic oxygen ring-containing compounds are pyrones, but only three alkyl derivatives have been identified[20].maltol, the 2-methyl-3-hydroxy-1,4- pyrone, is found at a concentration of 40 mg/kg in both Arabica and robusta roasted coffees[19]. that compound naturally occurring substance sold as a food flavor-enhancing agent. maltol is rapidly metabolized and excreted as sulfate and glucuronide conjugates, and 88% of the total excretion occurred in the first 6 hours[36].

Quinolines

Four benzos (b)pyridines (quinolines) have been detected in roasted coffee[20].and also formed in the body from tryptophan metabolism[24].16ng/kg level of quinoline in regular hot-air-roasted coffee beans was considered[37].

Naphthalene

Naphthalene and six other derivatives, 1-methyl, 2-methyl, dimethyl, 2-ethyl, trimethyl, and

tetra methylnaphthalene were identified in roasted coffee[19].they are present only in trace q-uantities in coffee[38,39].

Other compounds

Kahweol furan is an unusual heterocyclic product of particular importance to flavor and is found in roasted coffee at a level of 0.45-2.0 mg/kg. [19,20]

ALIPHATIC COMPOUNDS :

About 190 aliphatic compounds have been identified in green and roasted coffees. [19] green coffee beans decompose complex carbohydrates and converted them into 37 carboxylic acids during roasting.

The main acids found in significant quantities are malic, citric, lactic, succinic, and glycolic acids. [20]

Methylglyoxal

Other aldehydes have been more extensively investigated, particularly glyoxal and methylglyoxal. It was detected not only in coffee but also in various other beverages such as black tea, whiskey, brandy, wine, beer, fruit juices, cola, and foods including bread, tomatoes, boiled potatoes, and soya sauce[40,20].

LIPIDS :

Palmitic acid and linoleic acid are the most important fatty acids present in roasted coffee, which contains 11-16% w/w lipids in Arabica and 4-11% in robusta. About 79% of these lipids are present as triglycerides along with unsaponifiable's such as terpene esters (17%), while the remaining 4% are sterols, free terpenes, tocopherols, waxes, and unknown substance[20,19].

Terpenes

Cafestol and kahweol are the main diterpenes specific to coffee[41].water-soluble diterpene glycosides of the courage and kaurene types have been found, particularly in Arabica coffee. Atractyligenin is present in coffee both as the free compound and as the aglycone of three glycosides. The total atractyligenin content of roasted Arabica coffees varies from 0.64 to 1.24 g/kg and free atractyligenin from 0.06 to 0.12 g/kg. [42]roasted robusta coffee contains only one-tenth or less atractyligenin and its derivatives. On roasting, total atractyligenin decreases by about 35%.[43]

Sterols

Various sterols are present in coffee oil and constitute about 5.4% of the total lipids. The most important sterols are beta-sitosterol(53%), stigmasterol(21%), campesterol(11%), and cycloartenol (8%). [19,24].there is no evidence of sterols in brewed coffee[20].

OTHER COMPOUNDS:

Waxes

Coffee waxes represent 0.2-0.3% of the total lipids[44] and contain mainly 5-hydroxytryptamine derivatives of arachidonic, behenic, lignoceric, and stearic acids. Hydroxytryptamides partly decompose during roasting, and most of the residue remains in the spent grounds. Waxes of different plant origins are poorly absorbed, but they may have physiological effects along the gastrointestinal tract. The administration of regular and dewaxed coffee showed that waxes stimulate gastric acid secretion by enhancing gastrin release[45].

Hypercholesterolemic factors

An epidemiological study showed the effect of coffee on serum cholesterol[46].several research teams tried to identify the specific effects of caffeine, and those of the blend and the degree of roasting, before concluding that a hypercholesterolemic substance was either formed or extracted during the preparation of boiled coffee[47].

Phytoestrogens

The first report on the presence of a compound with estrogenic activity in coffee oil was published in 1938[48] the biologically active fractions isolated have a characteristic ultraviolet absorbance spectrum that excludes the presence of flavonoid, coumestan, or isocyclic acid lactone compounds, generally regarded as the primary classes of phytoestrogens.

Impact Of Coffee On Health :

Effect on the cardiovascular system

In the 1960s, researchers first looked into the link between coffee drinking and the risk of developing heart disease[49]. Since 2000, researchers have paid increased attention to the links between coffee intake and heart diseases such as heart failure and stroke[50,51]. According to a meta-analysis published in 2014, heavy coffee consumption—defined as six or more cups per day—was neither associated with a higher risk of cardiovascular disease nor a lower risk. Moderate coffee consumption—defined asthree to five cups per day—was associated with a
lower risk of cardiovascular disease[52] A2A receptors are involved in vasodilation in the aorta and coronary artery, and pharmacological studies have shown that A1 receptor activation has several effects on the cardiovascular system, including a reduction in heart rate and atrial contractility and the attenuation of the stimulatory actions of catecholamines on the heart[53]. Caffeine's ability to inhibit these receptors may be a factor in coffee's ability to protect against cardiovascular disease. Additional research revealed the presence of additional substances besides caffeine, which was supported by research with unfiltered and paper-filtered coffee [54] or coffee that has both caffeine and caffeine-free [55]. By reducing oxidative stress (reactive oxygen species), chlorogenic acids and their metabolites, for instance, can lower blood pressure by improving endothelial function and nitric

oxide bioavailability in the arterial vasculature [56]. Conclusion: Despite its limitations, the existing evidence supports the claim that there is no clinical evidence linking moderate coffee use to an increased risk of cardiovascular disorders, including stroke. The effects of coffee on the cardiovascular system may not just be due to caffeine[57].

Type 2 diabetes

Studies have shown that coffee has health benefits against metabolic disorders like type 2 diabetes, which has just recently attracted the attention of scientists as a current epidemic[58]. There is a strong inverse relationship between coffee drinking and the risk of diabetes, as shown by the systematic review and meta-analysis based on 1 109 272 research participants and 45 335 instances of type 2 diabetes. Six cups of coffee per day was linked to a 33% decreased incidence of type 2 diabetes than not drinking any coffee. Both men and women showed the same connection [59]. Contrarily, a multi-ethnic cohort study [60] revealed that drinking coffee had a higher protective effect on women than on males (14% lower diabetes risk compared to 34% lower diabetes risk). The mismatch may result from the self-reported dietary surveys' estimate of coffee use. Therefore, misclassification cannot be entirely disregarded. Comparing the effects of caffeinated and decaffeinated coffee consumption with the risk of type 2 diabetes was another objective of Ding's systematic review [59]. To confirm earlier findings of the European Prospective Investigation into Cancer and Nutrition (EPIC)-Germany study [61], which reported a 23% lower incidence for caffeinated and a 30% lower risk for decaffeinated intake of 4 cups/day, decaffeinated coffee consumption was associated with the same level of protection as seen for caffeinated coffee. The mechanism(s) through which the diabetes-preventive action is brought about, however, is still unknown. There is evidence for both improved insulin sensitivity and higher insulin secretory response [62].

Coffee seems to affect glucose homeostasis largely, if not completely, postprandial as opposed to fasting [63].

Liver Diseases

The data supporting the preventive effects of coffee drinking in the onset and progression of liver disease resulting from diverse sources is growing. Wadhawan and Anand examined the clinical evidence of the benefits of coffee drinking in 2016 [64] for hepatitis B and C, nonalcoholic fatty liver disease, and alcoholic liver disease, while Liu et al. reviewed it in 2015 [65] for hepatic fibrosis and cirrhosis. According to the two meta-analyses, coffee consumption of more than two cups per day is linked to lower rates of cirrhosis and fibrosis, hepatocellular carcinoma, as well as lower mortality rates in individuals with preexisting liver disease. In support of this defense, the NHANES I and III[66,67], two recent population-based investigations, found that higher coffee consumption (> 2 cups per day) was related to a decreased risk of elevated ALT levels by 44% as well as a lower risk of chronic liver disease when compared to non-coffee drinkers. Furthermore, a recent large cohort

research [68] of 330 patients with alcoholic and non-alcoholic cirrhosis revealed a substantial inverse association between coffee use (> 4 cups per day) and higher blood enzyme levels, particularly in those who drank large amounts of alcohol. Additionally, drinking coffee reduced liver stiffness, which would point to less fibrosis and inflammation in those with nonalcoholic fatty liver disease and hepatitis C and B virus infection [69]. Although drinking coffee has been linked to a lower incidence of liver disease, it is unknown if the impact is due to caffeine or other ingredients. Several investigations employing common rodent models of experimental liver fibrosis have shown that caffeine has protective effects against liver fibrosis. Consuming coffee or caffeine prevented toxins from inducing liver fibrosis or cirrhosis in almost all studies [70]. Caffeine was specifically found to decrease the activation of hepatic stellate cells in experimental models of fibrosis by blocking A2A receptors, and recent research suggests that caffeine may also have a positive effect on angiogenesis and hepatic hemodynamics. Gressneret al. [71] have successively demonstrated that caffeine reduces TGF—induced CTGF expression in hepatocytes. When rats with chemically induced liver fibrosis are given coffee and caffeine, their TGF- levels are lowered [67,72,73]. However, according to Vitaglione et al. [74], drinking decaffeinated espresso coffee helped mice with hepatic steatosis, inflammation, and fibrosis as well. Consequently, it is proposed that some coffee constituents contribute to the hepatoprotective effect and that caffeine in coffee is not necessary [59,75,76]. Hepatoprotective properties are present in chlorogenic acid [77]. The acid pretreatment appears to be beneficial in reducing TCBQ-induced oxidative stress, demonstrating a hepatoprotective character, according to a recent study [78] on TCBQ- induced liver damage in mice. Chlorogenic acid also decreased liver fibrosis and collagen I and III expressions. Reduced levels of VEGF, TGF-, and -smooth muscle actin was seen in these rats [79]. In rats and hepatocyte cultures, the diterpenes cafestol and kahweol may have protective effects against liver damage brought on by aflatoxin B1 [73,80]. Additionally, cafestol and kahweol may stimulate the production of glutathione, which aids in liver protection and cleansing. All things considered, a growing body of research consistently demonstrates a negative correlation between drinking coffee and liver disorders. There is not enough information, nevertheless, to draw definite conclusions concerning the relative significance of caffeine or other elements in coffee in the onset and development of liver disease.

Inflammatory Bowel Disease

According to studies to date, there is no connection between drinking coffee and the incidence of stomach cancer [84,85], dyspepsia [81], gastroesophageal reflux disease [82], peptic ulcers [83], gastritis, or dyspepsia [84,85]. Even though IBD sufferers drink coffee, it is still unclear whether doing so is safe for those with long-term digestive conditions. The two main kinds of IBD are CD and UC. Ng et alstudy .'s [86] found that coffee has a preventative effect against the growth of UC. According to another study [87] that followed 41 836 postmenopausal women for 15 years, heavy

coffee consumption is negatively connected with the severity of inflammatory disorders. It is common knowledge that the herbal concoction of myrrh, coffee charcoal, and dried chamomile flower extract has anti- inflammatory and antidiarrheal qualities. 96 patients with inactive UC were assigned to receive either the herbal concoction or mesalazine for 12 months in a randomized, double-blind, double-dummy research [88]. Between the two groups, there was no discernible difference in the relapse rate. Additionally, there were no discernible differences in relapse-free duration, endoscopy, or fecal biomarkers. The herbal mixture altered the cytokine/chemokine signaling pathway's role in the gene expression of activated human macrophages in vitro. Gene expression for chemokines was specifically reduced. In the end, coffee charcoal extracts increased the release of IL10 from activated macrophages while inhibiting the formation of CXCL13, which regulates the arrangement of B cells within lymphoid tissue follicles [89]. Caffeine-treated mice in vivo showed a delayed response to DSS-induced colitis, as seen by decreased body weight loss and better clinical and histological results (2.5 mM, or the amount of caffeine in 2-3 cups of coffee). The caffeine-treated animals with DSS-induced colitis produced fewer proinflammatory cytokines and had less bacterial translocation into other tissues. Additionally, caffeine administration reduced the activity of the signaling pathway linked to CHI3L1 [90]. Although it was not present in normal control subjects, disease-associated CHI3L1 expression was seen in colonic tissue samples taken from CD and UC patients [91]. However, it is believed that coffee's effects are not solely attributed to caffeine and may also be related to other distinct ingredients [92]. By lowering the macroscopic damage score, myeloperoxidase activity, and inhibiting the NF-B-dependent pathway, chlorogenic acid demonstrated a considerable anti-inflammatory action in a well-established mouse model of experimental colitis [93].In addition to these, cyclooxygenase-2 inhibition, suppression of inducible nitric oxide synthase (iNOS) without cytotoxic impact, dose-dependent attenuation of IL- 1 and IL-6 along with TNF-a, and inhibition of NF-B by chlorogenic acid in DSS-induced colitis have all been reported recently [94]. Even though clinical practice guidelines [95] advise persons with IBD to avoid caffeine, additional clinical and experimental research suggests that coffee and its components may have a future impact on IBS symptoms or other inflammatory gastrointestinal disorders.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

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HUMAN AND ANIMAL RIGHTS

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CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

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