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Review Article

Ethnic and paleolithic diet: Where do they stand in inflammation alleviation? A discussion

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A B S T R A C T

The current food options, especially in the Western countries, are acidogenic, which reduce extracellular pH and perturb ionic homeostasis. The acidity-activated enzymes mediate a large panel of chronic and acute diseases.

To quell the morbidities and mortalities associated with the metabolic syndromes, nonpharmacologic approaches are preferred. Dietary interventions are critical in this regard. Among the array of dietary patterns, paleo diet has garnered much attention in the last decade. This diet rich in phytochemicals and unsaturated fatty acids is deemed wholesome for the body. Several studies have proven this claim, yet their nutritional adequacy for all age groups is contentious. The popularity of ethnic foods is rising; but their nutrition and safety position can vary. Although some of them are close to paleo food, some are unhealthy. This review explores the mechanism by which paleo diet restores homeostasis of the body and how its inherent nutritional deficiency can be amended with conventional diet, by the formulation of personalized diet. This compilation is expected to be insightful for dietary optimization.

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Introduction

Paleolithic diet or paleo diet, the food habits of humans during the Paleolithic Era (45,000–40,000 to 10,000 BC) has got immense popularity in recent times, in keeping with the rising instances of inflammatory diseases, autoimmune pathologies, and cancers. A paleo diet is a modern dietary regimen based on foods presumably eaten regularly during the Paleolithic Era, which includes lean meat, fish, shellfish, fruits, vegetables, roots, eggs, and nuts, but not grains, dairy products, salt, or refined fats and sugar [1], which became staple food long after the appearance of fully modern humans [2]. While some believe that paleo diet is indeed healthy promoting, some dismiss it as “hype” or “fad” [3]. However, current evaluations have supported that this diet is compatible for health, and it should be made a staple in food platter. The explanation is that the human body has evolved to its current state because of nourishment by fruits, tubers, nuts, etc. [4]. Paleolithic diet was alkalogenic; therefore, it kept human extracellular fluid pH neutral, a requisite for homeostasis. However, with the progress of civilization, food paradigms changed drastically. With agriculture and animal domestication (Neolithic Revolution), diet was dominated by grains and dairy products. It tilted the extracellular fluid neutrality towards acidity [5]. But, industrialization (Industrial Revolution) and the emergence of processed food crossed the tipping point [5]. Increment in the consumption of processed foods, together with a reduction in fruit and vegetable intake, has dramatically changed the pattern [6]. The processed, high-carbohydrate, and high-fat diet increased the extracellular acidity, activated thezymogens, and inflamed the system [7]. No wonder, in current times, metabolic, autoimmune, endocrine, and neural diseases abound in mankind, especially in the developed regions of the world [8]. Ignorance of this culprit, combined with easy accessibility of drugs, is imposing further oxidative stress on the body [9,10] and skewing the pH toward more acidic. The phenotype of the modern human might have become refined today, but the genome is almost the same since the Paleolithic Era [11,12]. While the genome is static, the food habit has undergone radical change, which is taking toll on the mankind.

In realization of the adverse effects of changed food habits, there is a revival in interest for ethnic foods. Cajun cuisine which includes dish such as gumbo, jambalaya, and boiled crawfish are popular across the United States [13]. In Bedouin Arab minority
communities, ethnic foods include za’atar, leafy dark green vegetables, and camel milk [14]. Japanese ethnic dishes include fish and seaweed. Corn and flour tortillas, beans, tomatoes, chili peppers, lard, and beef tallow are cooking mainstays of Mexican foods.

Medical nutrition therapy is considered for the management of pathologies like end-stage kidney disease [15]. Diet therapy is the cornerstone of gestational diabetes mellitus. At the same time, the question of how ethnic dietary preference may be influencing diseases is coming forth. Not all ethnic foods are healthy in terms of their ingredients or processing technique. Polysaturated and monounsaturated fatty acids were found higher in most ethnic foods consumed in Italy and Spain compared with ethnic foods of other countries [16]. Ethnic and cultural factors determine dietary preferences. As globalization spreads across the world, societies are becoming multicultural and people are showing keen interest to taste the ethnic foods from different cultures. However, it might be difficult on the metabolism, as the genetics has evolved differently due to distinct dietary patterns. Salt-loaded seafood might be metabolized in a Japanese person but might cause hypertension in an Indian person. An European person might develop allergy to peanuts, while the nut can be a common ingredient in Chinese cuisine. Therefore, it is better to stick to one’s own diet. Even one’s own ethnic food should be consumed in moderation, as taste is not the reflection of the nutritional profile or antinutrients in the food. Cassava (Manihot esculenta Crantz) root is used as a food source in certain cultures [17]. It contains neurotoxic cyanogenic glycosides linamarin and lotaustralin, which can cause cyanide poisoning [17]. An excitatory amino acid L-ODAP (β-N-oxalyl-L-α, β-diaminopropionic acid) in Lathyrus sativus (grass pea or khesari dal), when ingested regularly, can cause paralysis [18,19]. An ethnic community, the Chamorro people of Guam, is often afflicted with neurodegenerative disease clusters of Alzheimer’s, Parkinson’s, and amyotrophic lateral sclerosis, because of their consumption of cyacid (Cycas micronesica) seeds, which contains neurotoxins beta-N-methylamino-L-alanine [20]. The Japanese traditional puffer fish (fugu or blowfish) contains tetrodotoxin, which if consumed can be fatal [21]. Japanese people have learned to ferment the fish to reduce its toxicity. A bamboo species Phyllostachys edulis, used as food, contains α-amylase inhibitors such as orientin, isoorientin, vitexin, and isovitexin. The leaves are soaked, heat inactivated, and cooked to eliminate the inhibitors. Ethnic foods have their origin in the availability of the ingredients.

Whatever was abundant or easily obtained dominated as ethnic food. Food scarcity has led to the invention of different strategies to deal with antinutrients and to make the most of the available materials. Before agriculture succeeded and globalization improved the food scenario, people in different countries had to deal with drought and famine, which often compelled them to integrate odd things to their food platter. Therefore, what may come across as delicious for a particular culture might appear gross to the other. “Huitlacoche,” the Ustilago maydis — caused fungal gall on corn cobs (Zea mays L.), was a delicacy in Aztec cuisine and is relished in Latin America [22]. Obesity or a particular disease is pervasive in a culture because of the dominance of particular ingredients in the cuisine. Native American tribes living in harsh conditions subsisted on various plant and animal products, for their nutritional needs. Kutzadika people in Mono Lake region consumed alkali fly (Ephydra hians) pupae; Palute Indians consumed Pandora moth (Coloradaria pandora) larvae; the Maidu people consumed carpenter ants (Camponotus spp.); some tribes used secretions of mealy plum aphid (Hyalopterus pruni) as sugar. People in the Midwest of the United States used the katydid (Anabrus simplex) as food. In Oriental countries such as Thailand, Vietnam, and Cambodia, people eat grasshoppers, crickets, spiders, scorpions, ants, and weevil larvae. Chapulines, the grasshoppers (Sphenarium spp.), are eaten in Mexico and Central America [23]. In Japanese culture, wasp, silk moth, cicada, and grasshopper preparations are served in restaurants [24]. Casu Marzu, a putrid cheese made from sheep milk has maggots of cheese fly (Piophila casei) [25]. The consumption of bats, frogs, bird egg fetus, and swiftlet bird’s nest is prevalent in different parts of the world. Tibetans are a high-altitude community, and they thrive with limited food resources because of their genes that adapt to particular low-temperatures (HIF2A/EPAS1 and EGLN1) [26]. Other people exposed to these meager food settings may develop nutritional deficiencies. The Maasai, tribe of Tanzania, are seminomadic people, and their pastoralist way of living exposes them to severe food insecurity, though meat, milk, and ugal (a thick maize-based porridge) constitute their primary food [27].

In current times, people are showing interest for exotic ethnic foods. Japan’s sushi, Italy’s pasta, El Salvador’s fried plantains, Afghanistan’s kabob, India’s curry, Ireland’s fish and chips, Ethiopia’s injera, Vietnam’s noodle soup, Hawaii’s poke (raw fish salad), and Mexico’s burrito, which were once ethnic food of a particular region of country are now global fare. Fig. 1 presents some ethnic foods

Fig. 1. Some ethnic foods from different countries. (A) Injera. (B) Kabob. (C) Fried banana. (D) Poke. (E) Biryani. (F) Noodle soup. Some of these ethnic foods are of high calorie, high protein, and high fat, while some are nutrition poor.
from different countries. Even, they are showing interest for such bizarre preparations as part of food tourism and for the sake of tasting exotic foods. However, the risks are not considered. Snake wine, alcohol steeped with venomous snake, is sold in China, consumption of which had led to cases of coagulopathy [28]. Arthropods have chitin and tropomyosin which can cause allergy and anaphylaxis [29]. Food professionals suspect the hygienic practice and labeling of the ethnic food preparations. Mycotoxins such as trichothecenes and ochratoxin A are present in chilli powder, curry powder, and ginger [30]. Kidney bean, which is a staple in Hispanic cuisine, is known to cause allergic incidents in people with different genotypes. This review analyses the pros and cons of the paleo diet. Further, the overlap between ethnic foods and paleo foods has been discussed.

**Paleolithic diet**

In a 3-month-long randomized crossover study, a paleo diet ingestion improved the glycemic control and several cardiovascular risk factors in type 2 diabetes patients [1]. In an observational study, paleo diet reduced the risk of a number of metabolic syndromes, as determined from the decline in weight, C-reactive protein, glycated hemoglobin, improved blood pressure, glucose tolerance, insulin level, and lipid profiles [5]. Frassetto et al also found that 10 days of a paleo diet improved the diastolic blood pressure, insulin sensitivity, and lipid parameters [31]. Paleolithic diet is associated with lower levels of systemic inflammation and oxidative stress in humans, as determined from the low-plasma high-sensitivity C-reactive protein and F2-isoprostane level (Whalen et al, 2016). F2-isoprostane and is a specific prostaglandin F2-like compound, derived from the nonenzymatic peroxidation of arachidonic acid. A paleo diet improves fat mass and metabolic balance, including insulin sensitivity, glycemic control, and leptin in patients with type 2 diabetes [32]. A randomized controlled study involving 2 weeks of paleo diet intake could ameliorate metabolic syndrome, especially cardiovascular risk factors [33]. A systematic review based on four randomized controlled trials resulted in short-term improvements in metabolic syndrome components following paleo diet [34]. A 4-month consumption of a paleo diet improved glucose control and lipid profiles in people with type 2 diabetes, compared with conventional diet (comprising moderate salt intake, low-fat dairy, whole grains, and legumes) [35]. Consumption of paleo diet increased incretin and anorectic gut hormones (glucagon-like peptide-1 and peptide YY), which improved satiety [36]. Paleo diet is rich in K+. Deficiency of this ion has been implicated in cardiovascular diseases, kidney stones, and osteoporosis. Therefore, a K+-rich paleo diet might have enough of this mineral to prevent the need of drugs or supplements [37]. A comparative study between the Western diet and paleo diet reveals that the latter can inhibit mammalian target of rapamycin complex 1 signaling, thus exerting effect on cell growth, proliferation, and angiogenesis [38]. In a case study, a female in her sixth decade, when subsisted on paleo-pattern food, her glycemic load and blood pressure issues were resolved [39].

**Western diet**

The Western diet is the reverse of paleo diet, which is dominated by high glucose, dairy protein, saturated fats, and trans fats [40,41]. Furthermore, this diet is brimming with sugar, salt, lipids, and additives. Preservatives like sulfites, nitrates, benzoic acid, emulsifier agents (polysorbate-80), and colors are being added liberally to the food for the augmentation of shelf-life and esthetic appeal. Such diet includes cheese, pizza, pasta, French fries, chocolates, mayonnaise, soft drinks, processed meat, and frozen foods [42,43]. Dairy products have hormones like prolactin, estrogen, progesterone, androgen, insulin-like growth factor-1, and prostaglandins [44]. Apart from those, other estrogenic, thyrostatic, and beta-adrenergic compounds are added to these foods, despite regulations [45]. Spectrometric analyses have identified trace amounts of pesticides like alachlor, atrazine, butachlor, isoproturon, malaoxon, methyl parathion, monocrotophos, phorate sulfone, phorate sulfoxide, 2,4-D, phorate, etc. in popular soft drinks [46]. Unfortunately, the current generation is under the grip of these acidogenic and pesticide-laced foods [47]. These types of foods are known to be acidogenic, for they tilt the acid–base balance in favor of acidity [48]. A majority of morbidities afflicting mankind today are attributed to the Western diet. Inflammatory ailments from the acne vulgaris to diabetes, tumorogenesis, sepsis, celiac disease, Crohn’s disease, inflammatory bowel disease, obesity, nonalcoholic fatty liver disease, cardiovascular disease, chronic obstructive pulmonary disease, chronic kidney disease, faster bone resorption, brain ischemia, etc. have been linked to the unhealthy constituents of the Western acidogenic diet [38,47,49,50].

**Mechanisms of amelioration**

The healthy aspect of paleo diet stems from its buffer-like effect on the body pH. Ions and electrolyte balance in the body is paramount for survival. None of the living organisms can escape the fluctuation in pH. The shift in pH usters in a deluge of undesirable consequences. Acidic milieu acts as stressors due to the abundance of reactive oxygen species, reactive nitrogen species, etc. [51]. The stressors favor the activation of a range of enzymes which ought to be dormant [52,53]. Proteases (matrix metalloproteases and cathepsins), nitric oxide synthase, adenosine triphosphate synthase, glycosidasases, urease (Ni2+-containing hydroxlate), phospholipase D, cyclooxygenase-2, and aromatase are some of the aberrantly activated enzymes which initiate pathologic cascades [54–62]. Acidosis induces mitogen-activated protein kinase phosphorylation, a requisite for pathologies [63]. Extracellular acidity activates proton-sensing proteins which prevent the actin polymerization (F-actin)/depolymerization (G-actin) process, which impedes cellular functions [64,65]. Together, they affect vesicular trafficking, autophagy, innate immunity, angiogenesis, proliferation, metastasis, apoptosis, etc. [58,66–68]. Drug resistance—mediating efflux protein, the P-glycoprotein, activity is increased by low intracellular calcium levels and high acidic pH [69–72]. Cancer-associated receptor proteins, the G protein—coupled receptors such as ovarian cancer G protein-coupled receptor 1, G protein-coupled receptor 4, and T-cell death-associated gene 8 act as proton sensors [73,74]. Subsequently, ion channels such as the proton-gated sodium channels are manipulated, and this ionic perturbation leads to pain [75–77].

Paleo diets are dominated by plant products and are not processed. Therefore, the polyphenolic phytochemicals quench reactive oxygen species and lower acidity [47,78–80]. Fig. 2 illustrates the mechanism of the Western diet and paleo diet mediating pathogenesis and restoring homeostasis, respectively.

**Discussion**

Owing to the inappropriate diet, by the time the individuals reach their forties, inflammatory diseases affect them. To get rid of the pathology, people seek sugar-free, fat-free, gluten-free, and probiotics–enriched diets. Awareness and moderation in food habits can go a long way in health retention. Inflammatory food consumption should be minimized to achieve optimal physiological pH of the body [81]. The inclusion of alkalogenic foods such as citrate, etc. in diet should be increased [42]. In fact, the Mediterranean food comprising whole grains, fruits, nuts, vegetable, seeds,
legumes, potatoes, and herbs is regarded the healthiest because of its alkalogenic ingredients [82–85].

Paleo diet is much ancient than diverse repertoire of ethnic diets. Thousands years of evolution, geographical relocations, and cultural practices led to the emergence of ethnic diet, from the paleo diet. Ethnic diets vary in their nutritional values, while some of them might be better than modern diet, some may not be. Biriyani and burrito are heavy in spice and oils, whereas injera is made of humble ingredients; poke and sushi are minimally processed. Furthermore, the ingredients used in the preparation of these ethnic foods need consideration while determining the food safety. Raw foods like might contain Norovirus [86], while the health effects of soy, sesame, etc., are debatable due to the role of phytoestrogens (isoflavone and lignan) present in them [87–89].

The current generation is focused mostly on weight loss and muscle development. Therefore, they do not resist the take steroids or supplements. These ingredients might be showing instant effect but in a long run they are not beneficial for the body. Whey protein [90], branched-chain amino acids (leucine, isoleucine, and valine), carnosine, l-arginine, glutamine, carnitine, ZMA (blend of zinc, magnesium aspartate, and vitamin B6), high molecular-weight carbohydrates, and beta-ecdysterone are nourishing for the musculoskeletal system, but these components are also neurotransmitters; therefore, they lead to other health problems.

Questions arise if paleo diet can meet the nutritional requirement of humans? Plant-based foods are low in calcium and vitamin D, the components essential for skeletal system health [1]. In this case, modern dietary ingredients should be used in moderation. However, it is important to understand the links. In diseases like osteoporosis, calcium is lost by bone demineralization. That does not mean one should take high doses of calcium supplements, as it will put strain on the kidneys [91]. Calcium is lost from bone, when the body fluid becomes acidic. It can be hypothesized that as paleo diet is not likely to raise acidity, calcium loss should not be an issue. Another publication also supports this hypothesis reporting that paleo diet has low phytates and sodium chloride content; therefore, it is less likely to increase acidosis [5].

The arguments that can be made against the inefficacy of paleo food have been outlined below. Dairy products like cheese and butter are acidogenic and insulinotropic, but they provide vitamin D, which is needed for health [5,92]. Also, the hunter–gatherer era involved raw consumption of food or probably limited fire usage. Therefore, the food is likely to contain gliadin, lectins, and saponins. These components are known to evoke immune response and to cause intestinal porosity [5,93,94]. A study hypothesizes that cooked foods required less energy for digestion, which led to the enhancement in brain size [95]. It challenges the benefit claims of paleo diet. These hypotheses are worthy of testing.

Also, modern diet with high protein may be harmful for adults, but not for adolescents. Furthermore, thousand years of evolution has generated diverse genotypes. Therefore, a “one-size-fits-all” dietary pattern is not going to help. Therefore, adherence to personalized diet is important [96]. Apart from that, depending on age, health status, and co-morbidity, the food habits need to be revised. In an inflammatory condition, an individual who used to digest animal protein–based foods might develop skin rashes while someone who used to metabolize dairy products might show intolerance.

Finally, it is important to realize that apart from diet, other factors are causal of inflammation. These nondiet factors include infections (virus, bacteria, protozoa, nematode, and fungi), allergens (plant pollen, arthropod chitins, metal, etc.), and occupational exposure [97–99]. The all-pervasive pollution, reckless usage of drugs, and chemical toiletries are other cardinal inflammatory agents [100–103]. Therefore, before attributing paleo diets as antiinflammatory, effects of these agents ought to be verified. If an individual’s lifestyle includes above inflammatory agents, the best of nutritious diet, be that paleo or ethnic origin, cannot help alleviate a health condition. For systemic well-being, a holistic and disciplined life is of paramount importance.

Conclusion

Acidogenic foods lead to drop in body pH, which initiate a cascade of enzyme activation, inflammation, and tumors. In this regard, dietary correction by adoption of paleo diet appears to be a holistic solution toward good health. Several clinical cases and cohort studies have proven that paleo diet is capable of preventing metabolic syndrome, but the consumers’ age, gender, and health status are critical parameters in its efficacy.

Conflicts of interest

The authors have no conflicts of interest to declare.

Compliance with ethical standards

This work does not involve human participants or animal models.

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