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Qabul qilingan sana: 07.12.2025
Nashr etilgan sana: 27.01.2026

Mahesh P.

Email : poojamahesh003@gmail.com

Tashkent State Medical University, Tashkent, Uzbekistan

AIR FRIED FOODS AS A HEALTHIER CHOICE THAN DEEP FRIED FOODS FOR LIVER AND METABOLIC HEALTH, WITH THE FOCUS OF ACRYLAMIDE

Abstract: Liver diseases, mainly non alcoholic fatty liver disease (NAFLD) and metabolic disorders, are increasing widely, and beyond clinical factors, lifestyle and diet act to be the major contributing factors.

Multiple studies have proven that the Mediterranean diet has less prevalence of leading to liver diseases, as this diet is rich in nuts, vegetables, fruits, and unsaturated fats. At the same time, the Western diet includes deeply fried foods, ultra-processed foods and saturated fats, which are more prone to cause liver diseases and metabolic disorders.

Several teams of authors have performed comparative studies between the deeply fried foods and air-fried foods in terms of their effects on metabolic health. Air-fried foods have been shown to contain 70% less fat, which leads to a 45 kcal reduction per 100g of chicken compared to the deeply fried food. Mainly, the chemical parameters, especially Acrylamide, showed better results in air-fried foods than deeply fried foods when cooked under a lower temperature.

This review aims to evaluate if air-fried foods are a healthier choice in relation to liver and metabolic health than deeply fried foods, while it also focuses on the limitations of starchy foods consumption, which is associated with the Acrylamide risk.

Keywords: Air frying, deep frying, liver health, metabolic health, Acrylamide

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Introduction: Non-alcoholic liver diseases are common liver diseases in western countries, as their diet is high in deeply fried foods, soft drinks, refined carbohydrates, and ultra processed foods that lead to accumulation of more fats in the form of triglycerides in the liver; whereas Mediterranean countries are less prone to cause liver diseases due to their diet being rich in fruits, vegetables, legumes, leading to lower fat deposition in liver.

How do fried foods affect metabolic health?

- In short, the liver stores fats as Triglycerides, and it can be divided into saturated fats and unsaturated fats and polyunsaturated fats.

- Saturated fats (like palmitic acid and stearic acid) are found in fried foods and processed foods, and promote lipotoxicity like oxidative stress, mitochondrial dysfunction and inflammation in the liver.

- Unsaturated fats (for example, oleic acid) are found in olive oil, nuts, avocados. They promote lipid metabolism and protect the liver from harmful storage.

- Polyunsaturated fats (omega-3 fatty acids) are contained in flaxseed, fish, and reduce inflammation, promote insulin sensitivity, and can reverse fat accumulation.

What is air frying, and why is it considered to be healthier?

Air frying is commonly used by many restaurants, industries for frying foods by hot air with no oil or minimal oil.

Obesity is one of the main causes of liver diseases. Air frying significantly reduces fat, which can lower calorie intake and postprandial triglyceride levels.

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Replacing deep-fried foods with air-fried foods can be a useful and practical strategy for NAFLD patients.

Acrylamide risk as a new concern

Acrylamide is a chemical produced from foods at high temperatures (>120 degrees Celsius) in processes such as cooking, frying, roasting, toasting and from high-carb foods.

Many studies implicate that Acrylamide can act as a potent neurotoxic agent.

Acrylamide is classified as a "probable human carcinogen" by the International Agency for Research on Cancer (1994).

An imbalance in the antioxidants ratio, oxidative stress may lead to excessive production of free radicals in the body and promote many diseases through cell or tissue injury.

The objective of the review is to examine whether air-fried foods represent a healthier choice over deeply fried foods, with particular focus on their impact on liver and metabolic health and associated risk of acrylamide formation.

Relevance: "Fried foods are often craved and are widely consumed by people, so for patients with liver diseases, replacing deep-fried foods with air-fried foods could offer a healthier option".

Frying foods is the common technique used frequently by people across the world; however, their high fat, calorie, and acrylamide content pose the risks of promoting liver diseases and deterioration of metabolic health. For patients with liver disease (non-alcoholic fatty liver disease), replacing deeply fried foods with air-fried foods may be considered a better diet strategy to reduce obesity, which is a major cause of the metabolic disorders and liver diseases, with reduction of fats, calories and other chemical parameters, mainly acrylamide. However, clinical

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evidence doesn't contribute to direct benefits to liver health and requires further investigation.

Air frying reduces oil uptake and calorie intake, has potential benefits mediated by reduced caloric intake and weight loss, which can be helpful in hepatocyte protection.

Materials and methods: This review was conducted by searching electronic databases, including PUBMED, GOOGLE SCHOLAR, SCOPUS, for articles published from 2015 to 2025. The keywords used were 'liver patients diet', 'NAFLD lifestyle', 'Deeply fried foods effects', 'Air frying foods benefits', 'Mechanisms of Acrylamide effects', 'Starchy foods', 'Millard reaction', and 'Health risks'. The studies that are included address the Acrylamide formation, deeply fried and air-fried foods effects on metabolic health, and associated health hazards in humans only. Studies excluded from revising are those not available in full text, not in the English language, and unrelated to health foods and human exposure. A total of 100 studies were identified, out of which 35 met the criteria. Data extracted from Acrylamide toxicity, mechanism of formation and effects, Diet lifestyle of patients with liver diseases and metabolic disorders, and preventive strategies. The findings were divided thematically into 4 categories: Diet and lifestyle, comparative studies of deeply fried and air-fried foods and mechanisms of their effects on liver and metabolic health, Toxicology and preventive strategies approach.

Results: Deep-fried food consumption leads to obesity, which contributes to liver disease and metabolic health complications. Deep frying is a traditional technique used by many restaurants, consumers and industries for frying foods, but it requires a large amount of oil, which leads to high contents of fats, calories and also acrylamide that affects the liver and is harmful for storage. These chemicals lead to an elevation in bilirubin, cholesterol, which contribute to damaging the liver.

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On the other hand, air-fried foods contain significantly less fat and fewer calories, though they provide similar taste, flavour, and crispiness to deeply fried foods. Considering that air-fried foods require minimal to no oil for frying, and also the formation of harmful substances, mainly acrylamide, is reduced, air-fried foods show comparatively better results than deeply fried foods.

Substituting deep-fried foods with air-fried foods consequently may be beneficial for patients with liver diseases and metabolic disorders, particularly focusing on the diets that limit starch foods like potatoes.

Parameter	Deep-fried Chicken (≈100 g)	Air-fried Chicken (≈100 g)	Notes / Implications for Liver Health
Calories	~ 220-260 kcal	~ 150-180 kcal	calories avoid weight gain / obesity, eases with liver complications (70-100 kcal Low)
Total Fat	~ 10-15 g	~ 4-6 g	Low fat helps in less storage and metabolism to liver (6-9g low)
Saturated Fat	~ 2-4 g	Typically < 2 g	Saturated fats causes lipotoxicity and liver inflammation.(2g low)
Acrylamide	Higher levels , up to ~ 6.19 µg/kg	Lower levels: up to ~ 3.49 µg/kg	Acrylamide, a harmful chemical; causes oxidative stress, possible carcinogenic risk, mitochondrial dysfunction leads to cell injury or death
Polycyclic Aromatic Hydrocarbons (PAHs) / Other Harmful Compounds	Greater formation total PAH ~ 2.64-3.17 µg/kg	Lower: ~ 1.96-2.71 µg/kg	PAHs produces inflammation to hepatocytes further damages liver.

Conclusions: Selecting air-fried foods over deep-fried foods, with precautions to limit starchy foods such as potatoes and with careful attention to acrylamide exposure, offers a healthier choice for patients with liver and metabolic disorders.

Air frying is a technique which provides a way to reduce oil uptake and lower calories, as well as acrylamide, while providing a satisfying taste and fried flavours that are often craved. This method can be widely adopted by consumers, food industries, and restaurants to promote better health outcomes. Further research is needed to strengthen the evidence base, raise public awareness, and encourage broader dietary changes toward safer frying practices for better healthy lifestyles and diets for patients with impaired metabolic health and liver diseases.

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