

REVIEW

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A review of environmental, technological, and socio-economic aspects of cultured meat

Roshini Singh¹, Sonal Prasad², Kaiser Younis^{3*} and Owais Yousuf^{4*}

*Correspondence:

Kaiser Younis
kaitech.doft@gmail.com
Owais Yousuf
mirowais33@gmail.com

¹Amity Institute of Biotechnology,
Amity University Uttar Pradesh,
Lucknow Campus,
Lucknow 226010, India

²Faculty of Biosciences, Institute of
Biosciences and Technology, Shri
Ramswaroop Memorial University,
Lucknow-Deva Road,
Barabanki 225003, India

³Department of Bioengineering,
Integral University,
Lucknow 226026, India

⁴Department of Food Technology,
Islamic University of Science &
Technology, Awantipora
192122, India

Abstract

Cultured meat is an emerging product with the potential to improve global food security, reduce animal suffering, and lessen the environmental impacts of conventional livestock farming. Producing meat from cultivated muscle cells may lower greenhouse gas emissions and resource use; yet, current production remains energy-intensive, raising fears about overall sustainability. Improving energy efficiency will be essential to realizing its environmental benefits. Despite its promise, cultured meat faces several challenges, including high production costs and difficulties in replicating the texture, taste, and nutritional profile of conventional meat. While costs are likely to decrease with technological progress, cultured meat also competes with widely accepted plant-based alternatives. Ethical and social factors further impact adoption, as the continued use of animal-derived cells and public scepticism toward lab-grown foods may hinder acceptance. Recent technological advances in cell cultivation, bioprinting, growth optimization, and tissue engineering have improved product quality and structural validity. This review highlights the potential of cultured meat as a sustainable alternative to conventional meat production, while critically examining its environmental implications, technological advancements, economic feasibility, and ethical and social challenges influencing its large-scale production.

Keywords Cultured meat, Sustainability, Food security, Energy efficiency, Animal welfare, Consumer acceptance, Tissue engineering

1 Introduction

Humans have consumed meat since the beginning, making it one of their primary protein sources. The conventional approach to producing meat involves poaching a live animal and requiring land. The world population is increasing rapidly and, according to the United Nations, it is projected to reach approximately 9.8 billion by 2050 [43]. According to the Food and Agriculture Organization (FAO), 70% more food will be required in 2050 to fulfill the demands of the expanding population. This presents a significant challenge since there are limited resources and agricultural land. Although meat consumption is declining in developed nations, consumers worldwide are often unwilling to reduce their meat intake, especially in developing countries in Asia, such as China, India, and Russia [68]. These populations are growing economically and want premium



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