Manifesto

in favore della cultura del cibo di qualità e contro il cibo artificiale e di laboratorio

TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA

La Nutrizione, tra qualità e sostenibilità

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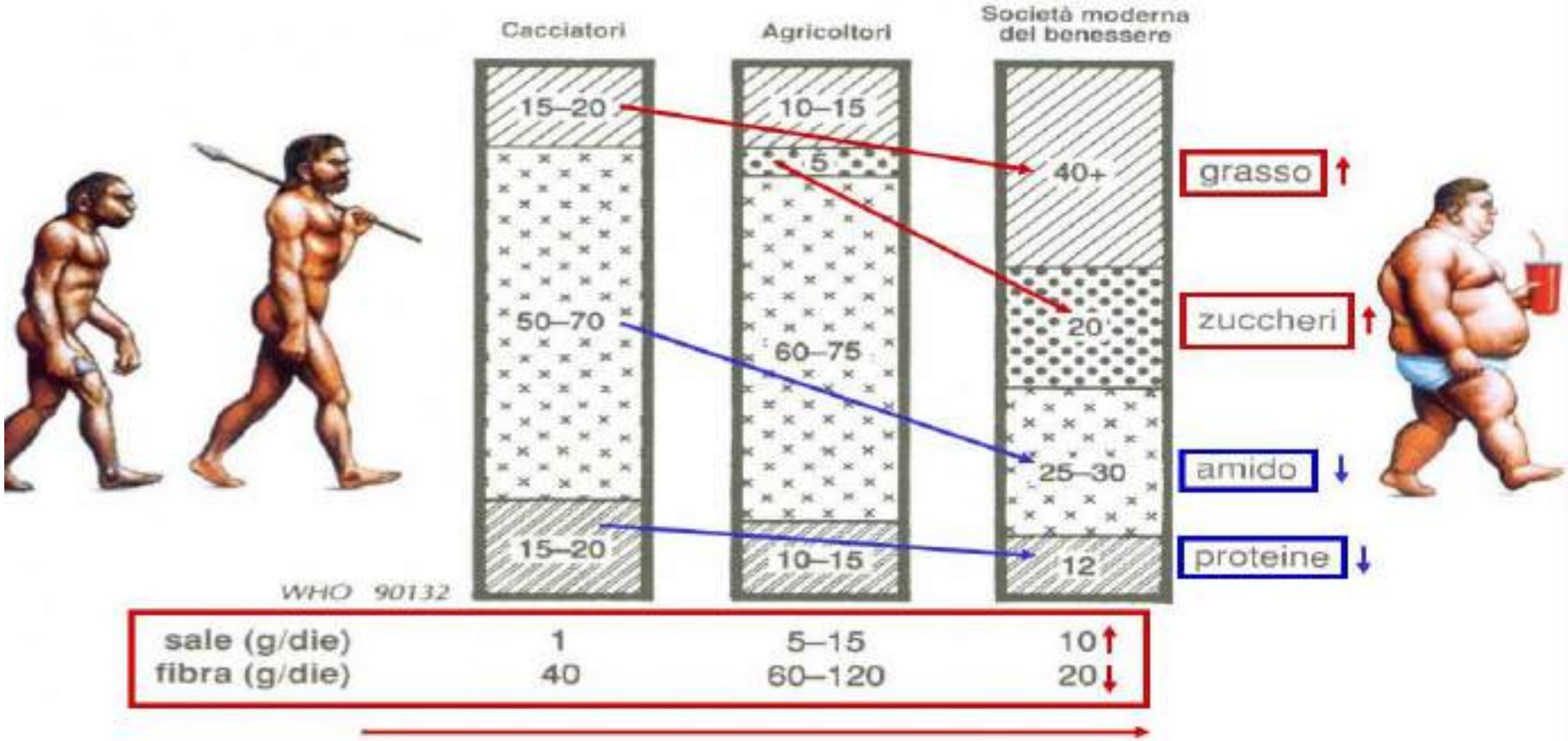
What is meant by an 'environmentally sustainable diet'?

'Sustainable Diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy while optimizing natural and human resources.'

FAO, 2010[31]

17 United Nations Sustainable Development Goals:
8 directly or indirectly relate to agriculture and food

The Things we eat have changed



The Lancet: Globally, 1 in 5 deaths are associated with poor diet

Globally, 1 in 5 deaths (11 million deaths) in 2017 were associated with poor diet, with cardiovascular disease being the biggest contributor, followed by cancers and type 2 diabetes

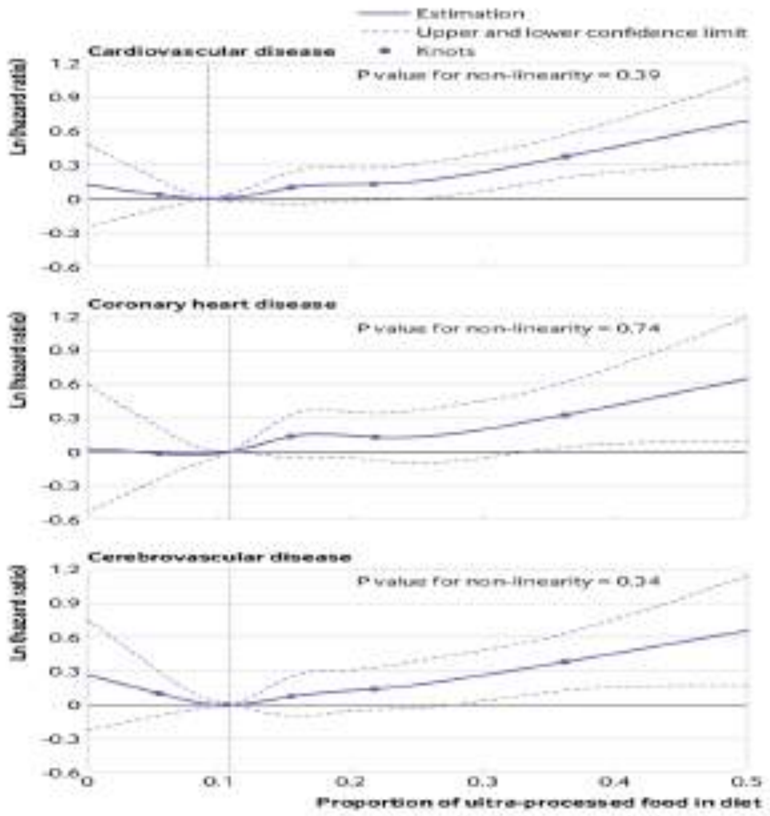


Fig 3 | Spline plot for linearity assumption of association between proportion of ultra-processed food in diet and risks of overall cardiovascular, coronary heart, and cerebrovascular diseases. Restricted cubic spline SAS macro developed by Desquilbet and Mariotti[43]

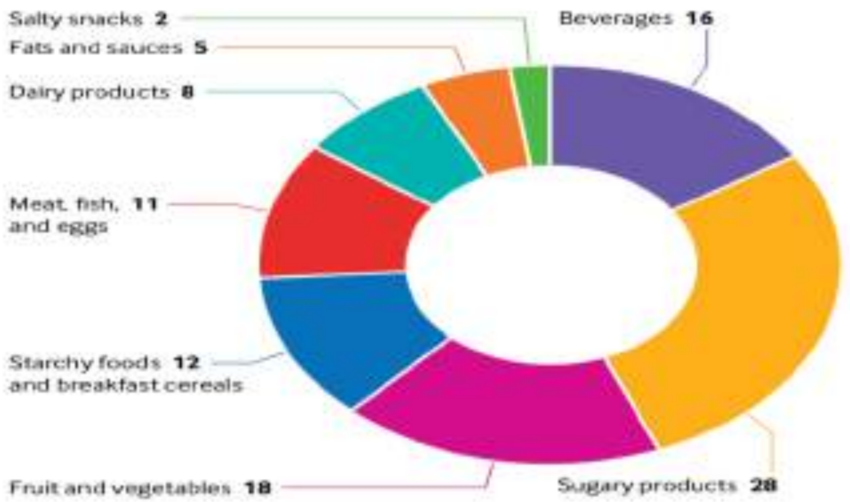


Fig 2 | Relative contribution (%) of each food group to consumption of ultra-processed food in diet

BMJ 2019;365:l1451

Ultra-processed food intake and risk of cardiovascular disease: prospective cohort study (NutriNet-Santé)

Bernard Srour,[1] Léopold K Fezeu,[1] Emmanuelle Kesse-Guyot,[1] Benjamin Allès,[1] Caroline Méjean,[2] Roland M Andrianasolo,[1] Eloi Chazelas,[1] Mélanie Deschasaux,[1] Serge Hercberg,[1,3] Pilar Galan,[1] Carlos A Monteiro,[4] Chantal Julia,[1,3] Mathilde Touvier[1]

Non-Communicable Diseases

Globally Non-Communicable Diseases (NCDs) kill 38 million people each year; almost three quarters of NCD deaths - 28 million - occur in low- and middle-income countries. Sixteen million NCD deaths (42%) occur before the age of 70; 82% of these "premature" deaths occurred in low- and middle-income countries.

46% Cardiovascular Diseases

21% Cancers

11% Respiratory diseases

4% Diabetes

ITALY

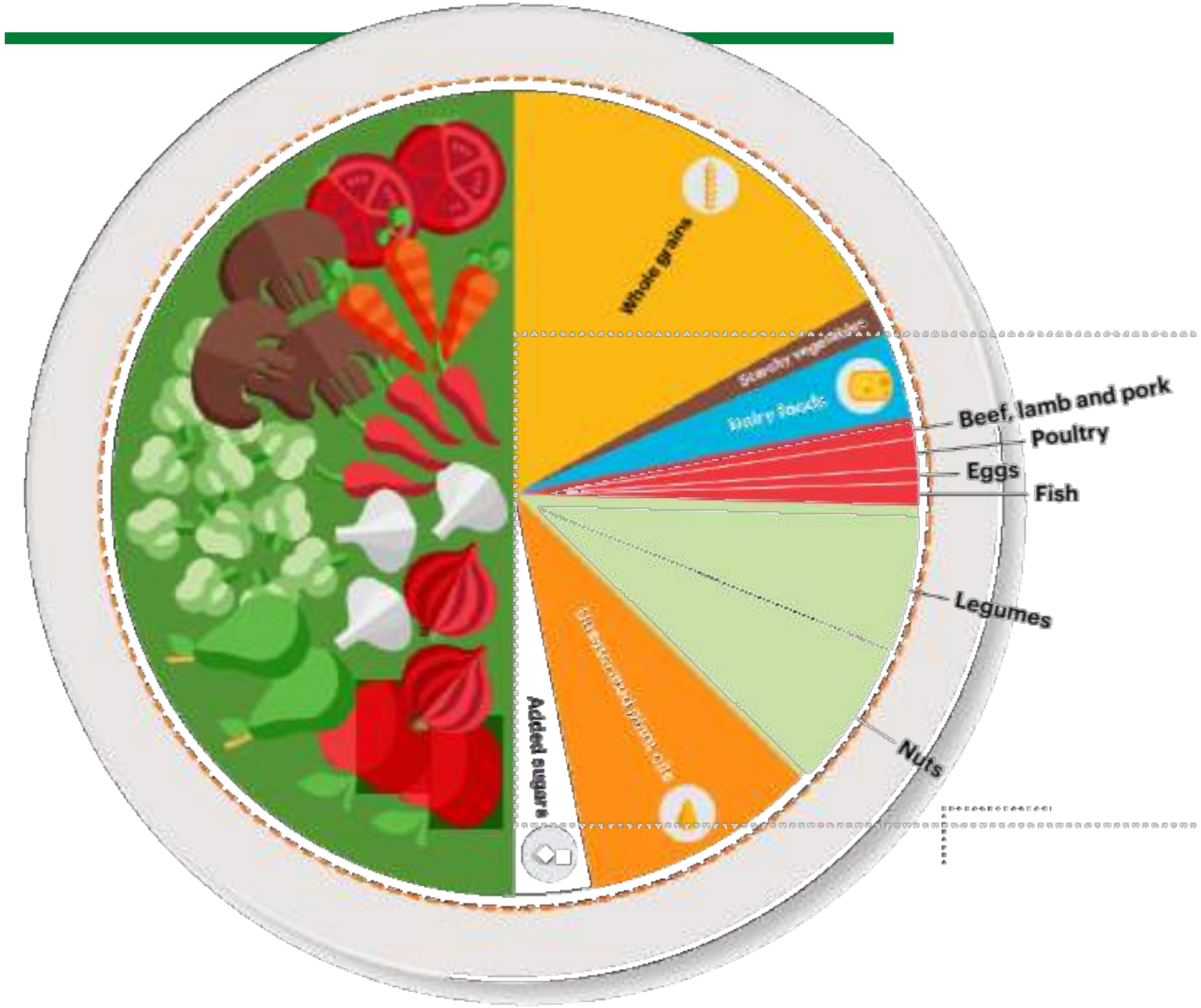
59 504 000	92%	573 000	9%
Total population	Percentage of deaths from NCDs	Total number of NCD deaths	Risk of premature death from target NCDs

1	National NCD targets	◐
2	Mortality data	●
3	Risk factor surveys	◐
4	National integrated NCD policy/strategy/action plan	●
5	Tobacco demand-reduction measures:	
a	increased excise taxes and prices	●
b	smoke-free policies	◐
c	large graphic health warnings/plain packaging	●
d	bans on advertising, promotion and sponsorship	◐
e	mass media campaigns	●
6	Harmful use of alcohol reduction measures:	
a	restrictions on physical availability	◐
b	advertising bans or comprehensive restrictions	◐
c	increased excise taxes	◐
7	Unhealthy diet reduction measures:	
a	salt/sodium policies	●
b	saturated fatty acids and trans-fats policies	●
c	marketing to children restrictions	●
d	marketing of breast-milk substitutes restrictions	◐
8	Public education and awareness campaign on physical activity	●
9	Guidelines for management of cancer, CVD, diabetes and CRD	◐
10	Drug therapy/counselling to prevent heart attacks and strokes	○

● = fully achieved ◐ = partially achieved ○ = not achieved

World Health Organization - Noncommunicable Diseases Progress Monitor 2017

EAT Lancet recommendations



	Macronutrient intake grams per day (possible range)	Caloric intake kcal per day
Whole grains		
Rice, wheat, corn and other	232	811
Tubers or starchy vegetables		
Potatoes and cassava	50 (0–100)	39
Vegetables		
All vegetables	300 (200–600)	78
Fruits		
All fruits	200 (100–300)	126
Dairy foods		
Whole milk or equivalents	250 (0–500)	153
Protein sources		
Beef, lamb and pork	14 (0–28)	30
Chicken and other poultry	29 (0–58)	62
Eggs	13 (0–25)	19
Fish	28 (0–100)	40
Legumes	75 (0–100)	284
Nuts	50 (0–75)	291
Added fats		
Unsaturated oils	40 (20–80)	354
Saturated oils	11.8 (0-11.8)	96
Added sugars		
All sugars	31 (0–31)	120

Ann Ig 2015; 27: 693-704 doi:10.7416/ai.2015.2061

Nutrition between sustainability and quality°

G.M. Fara*, MD, MPH

Keyword: Sustainability, aliments, quality, mediterranean diet
Parole chiave: Sostenibilità, alimenti, qualità, dieta mediterranea

La **sostenibilità** può essere misurata sotto diversi aspetti:

- ecologia (uso di acqua, energia e suolo)
- economia
- tutela della salute.

- La Nutrzione è "l'insieme di processi biologici che consentono, o influenzano, la sopravvivenza, la crescita, lo sviluppo e l'integrità di un essere vivente, sulla base di disponibilità di energia e nutrienti" [Regulation (EC) No. 178/2002, art 2, rev November 11, 2015]
- La sostenibilità in ambito di salute ci dice quanto un modello di alimentazione è adeguato, dal punto di vista nutrizionale, per garantire il buono stato di salute e persino il suo miglioramento.
- **La sostenibilità sanitaria deve considerare il cibo e la nutrizione sotto gli aspetti della quantità e della qualità.**

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Table 4 - Weekly Carbon, Water and Ecological impacts of the Mediterranean Diet compared to a hyperproteic and a standard Italian diet

Diets	Carbon Footprint (kg CO_2 equiv.)	Water Footprint (Liters of water)	Ecological Footprint (m^2 square meters soil employed)
Mediterranean	17.04	13,781	29
Hyperproteic	30.55	19,767	201
Standard Italian	24.09	16,745	170

Public Health Nutrition: 20(7), 1322–1330 doi:10.1017/S1368980016003177

Review Article

Med Diet 4.0: the Mediterranean diet with four sustainable benefits

S Dernini[1,2,3], EM Berry[1,4,*], L Serra-Majem[1,5,6], C La Vecchia[1,7], R Capone[1,8], FX Medina[1,9], J Aranceta-Bartrina[1,10], R Belahsen[1,11], B Burlingame[1,12], G Calabrese[1,13], D Corella[1,14], LM Donini[1,6,15], D Lairon[1,16], A Meybeck[1,3], AG Pekcan[1,17], S Piscopo[1,18], A Yngve[1,19] and A Trichopoulou[1,20], on behalf of the Scientific Committee of the International Foundation of Mediterranean Diet

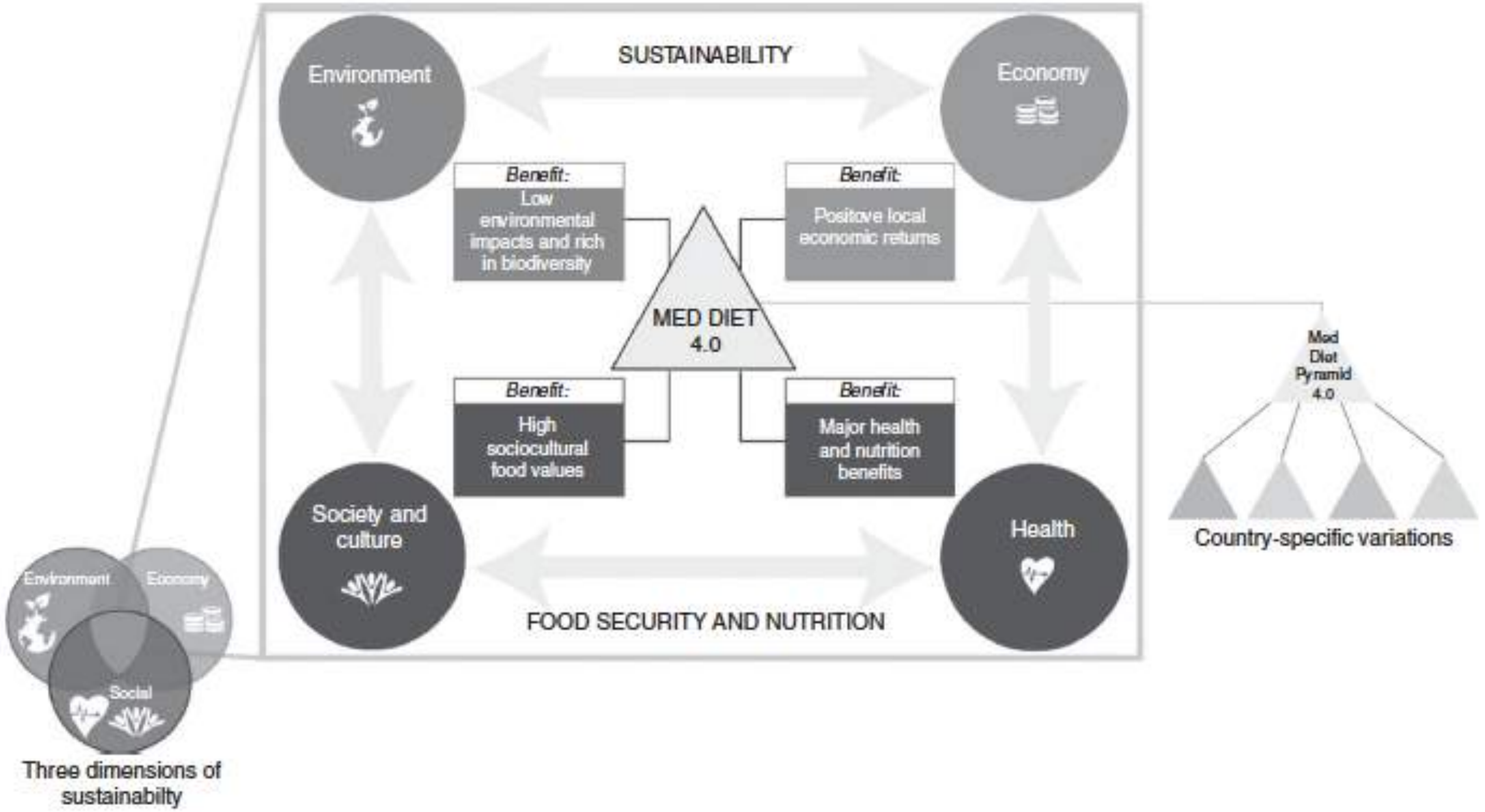

Fig. 1 The Med Diet 4.0 framework that applies the principles of sustainability to the four sustainable dimensions of the Mediterranean diet

TOR VERGATA

Calcolatore di Indice di Adeguatezza Mediterranea (MAI)

Con questo strumento è possibile calcolare il MAI di ricette composte da numero qualsiasi di alimenti. E' anche possibile inserire tutti gli alimenti che compongono un intero pasto.

Per ognuno degli alimenti da introdurre si inizia a digitare il nome dell'alimento nell'apposita casella: il sistema proporrà in tempo reale una lista di alimenti compatibili. E' assolutamente necessario scegliere una delle opzioni predefinite proposte dal sistema. Si inseriscono poi i grammi relativi all'alimento scelto. La procedura viene ripetuta per ogni alimento. Per inserire più di 10 alimenti utilizzare il tasto "Aggiungi Alimento".

La tua ricetta

Nome ricetta/pasto:

Alimento 1 Grammi

Alimento 2 Grammi

Alimento 3 Grammi

Alimento 4 Grammi

Alimento 5 Grammi

http://immuno.bio.uniroma2.it/maicalc/

The Nicotera Diet: The Reference Italian Mediterranean Diet

Flaminio Fidanza[a], Adalberta Alberti[a], Daniela Fruttini[b]

[a]Human Nutrition Unit, University of Rome-Tor Vergata, Rome, and WBC Section, CNR Research Center, Rome-Tor Vergata and [b]Department of Statistical Sciences, University of Perugia, Perugia, Italy

Nicotera, a small town in the Calabria Region in Southern Italy, was the third Italian rural area of the Seven Countries Study (SCS) examined in the fall of 1957 as a pilot study. Because both due to shortage of funds and similarity with the two rural areas of Greece, this study was not followed longitudinally.

Nicotera, selected for the quite high olive oil and legumes consumption, is perched on a spot of the Poro Mountain overlooking the Tyrrhenian Sea about 60 km north of Reggio Calabria near the toe of Italy. The main farm products were olives, grapes, figs, oranges, tomatoes, pulses, wheat, bergamot for the perfume trade, and for local use, a little meat and poultry. In the hamlet of Nicotera Marina few families were engaged in fishing. There was no manufacturing industry. The population was relatively poor in comparison to the two rural areas of Italy in the SCS, but there was a migration of persons under the age of 40. Besides the main center of Nicotera and the hamlet of Nicotera Marina there were three more detached hamlets: Comerconi, Badia, and Preitoni. The total population of the entire survey area was 9,043 inhabitants at the time of the survey. About 80% of the people lived in the centers and went out daily to work in their small fields often as far as several kilometers away. Both men and women were engaged in moderate physical activity and only men in some cases in rather heavy physical work. Because of its geography (altitude 0–641 m) and road conditions, transportation was mainly by mule. The prevalence of myocardial infarction in men aged 45–64 years was very low (4 cases out of 598 examined in 1957), and hypertension, overweight and obesity were uncommon. Similar findings were observed in the cohort of men from Corfu (Greece) examined in 1960.

Indice di Adeguatezza Mediterraneo (IAM)

$$\text{IAM} = \frac{\text{\% energia da CARBOIDRATI + PROTETTIVI}}{\text{\% energia da DERIVATI ANIMALI + DOLCI}}$$

Carboidrati: *pane, cereali, legumi, patate*
Protettivi: *vegetali, frutta, pesce, vino rosso, olio d'oliva*
(Gruppi di alimenti appartenenti alla dieta mediterranea)

Derivati animali: *latte, formaggio, carne, uova, grassi animali e margarina*
Dolci: *bevande dolci, biscotti/torte, zucchero*
(Gruppi di alimenti non appartenenti alla dieta mediterranea)

Alberti et all. Eur J Clin Nutr 1999

nutrients

MDPI

Review

Science and Healthy Meals in the World: Nutritional Epigenomics and Nutrigenetics of the Mediterranean Diet

Fabio Caradonna *, Ornella Consiglio, Claudio Luparello and Carla Gentile

Department of Biological, Chemical and Pharmaceutical Sciences and Technologies, University of Palermo, Viale delle Scienze, edificio 16, 90128 Palermo, Italy; ornella.consiglio@libero.it (O.C.); claudio.luparello@unipa.it (C.L.); carla.gentile@unipa.it (C.G.)

* Correspondence: fabio.caradonna@unipa.it

Received: 18 April 2020; Accepted: 8 June 2020; Published: 11 June 2020

check for updates

Abstract: The Mediterranean Diet (MD), UNESCO Intangible Cultural Heritage of Humanity, has become a scientific topic of high interest due to its health benefits. The aim of this review is to pick up selected studies that report nutrigenomic or nutrigenetic data and recapitulate some of the biochemical/genomic/genetic aspects involved in the positive health effects of the MD. These include (i) the antioxidative potential of its constituents with protective effects against several diseases; (ii) the epigenetic and epigenomic effects exerted by food components, such as Indacaxanthin, Sulforaphane, and 3-Hydroxytyrosol among others, and their involvement in the modulation of miRNA expression; (iii) the existence of predisposing or protective human genotypes due to allelic diversities and the impact of the MD on disease risk. A part of the review is dedicated to the nutrigenomic effects of the main cooking methods used in the MD and also to a comparative analysis of the nutrigenomic properties of the MD and other diet regimens and non-MD-related aliments. Taking all the data into account, the traditional MD emerges as a diet with a high antioxidant and nutrigenomic modulation power, which is an example of the "Environment-Livings-Environment" relationship and an excellent patchwork of interconnected biological actions working toward human health.

Keywords: nutrigenetics; nutrigenomics; Mediterranean diet

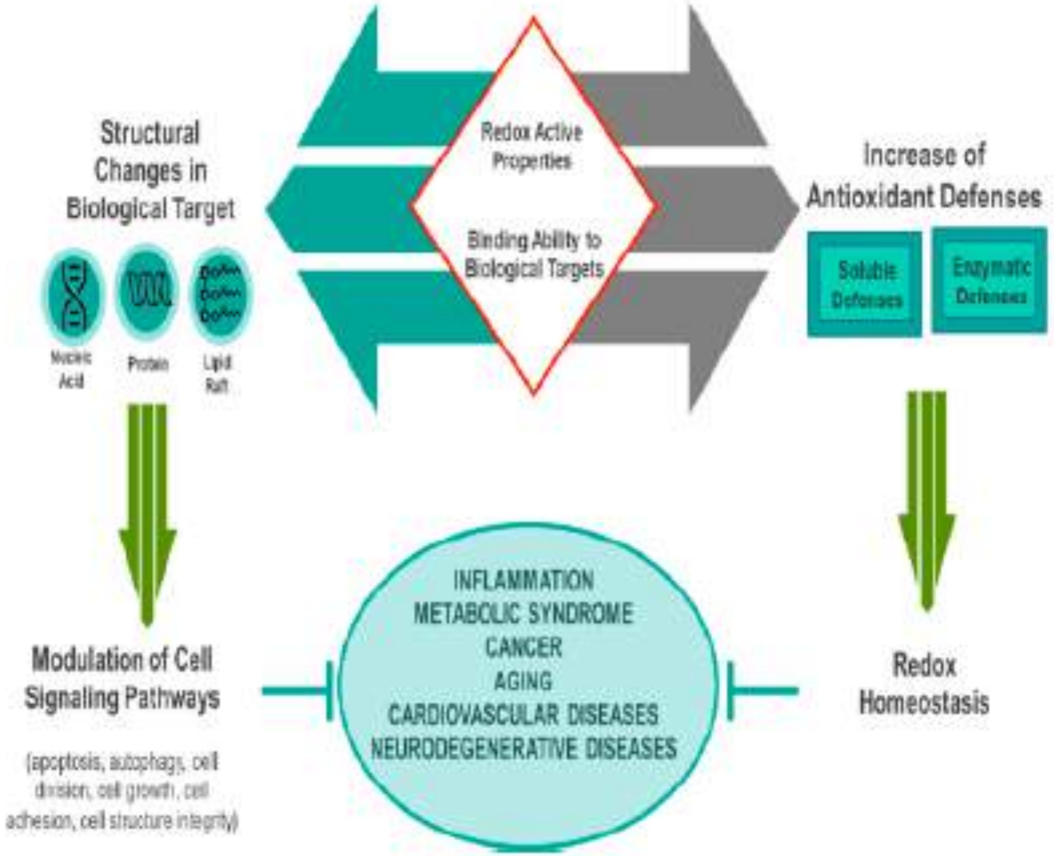

Figure 1. Biochemical mechanisms of phytochemical bioactivity.

nutrients MDPI

Review

Science and Healthy Meals in the World: Nutritional Epigenomics and Nutrigenetics of the Mediterranean Diet

Fabio Caradonna *, Ornella Consiglio, Claudio Luparello and Carla Gentile

Department of Biological, Chemical and Pharmaceutical Sciences and Technologies, University of Palermo, Viale delle Scienze, edificio 16, 90128 Palermo, Italy; ornella.consiglio@libero.it (O.C.); claudio.luparello@unipa.it (C.L.); carla.gentile@unipa.it (C.G.)

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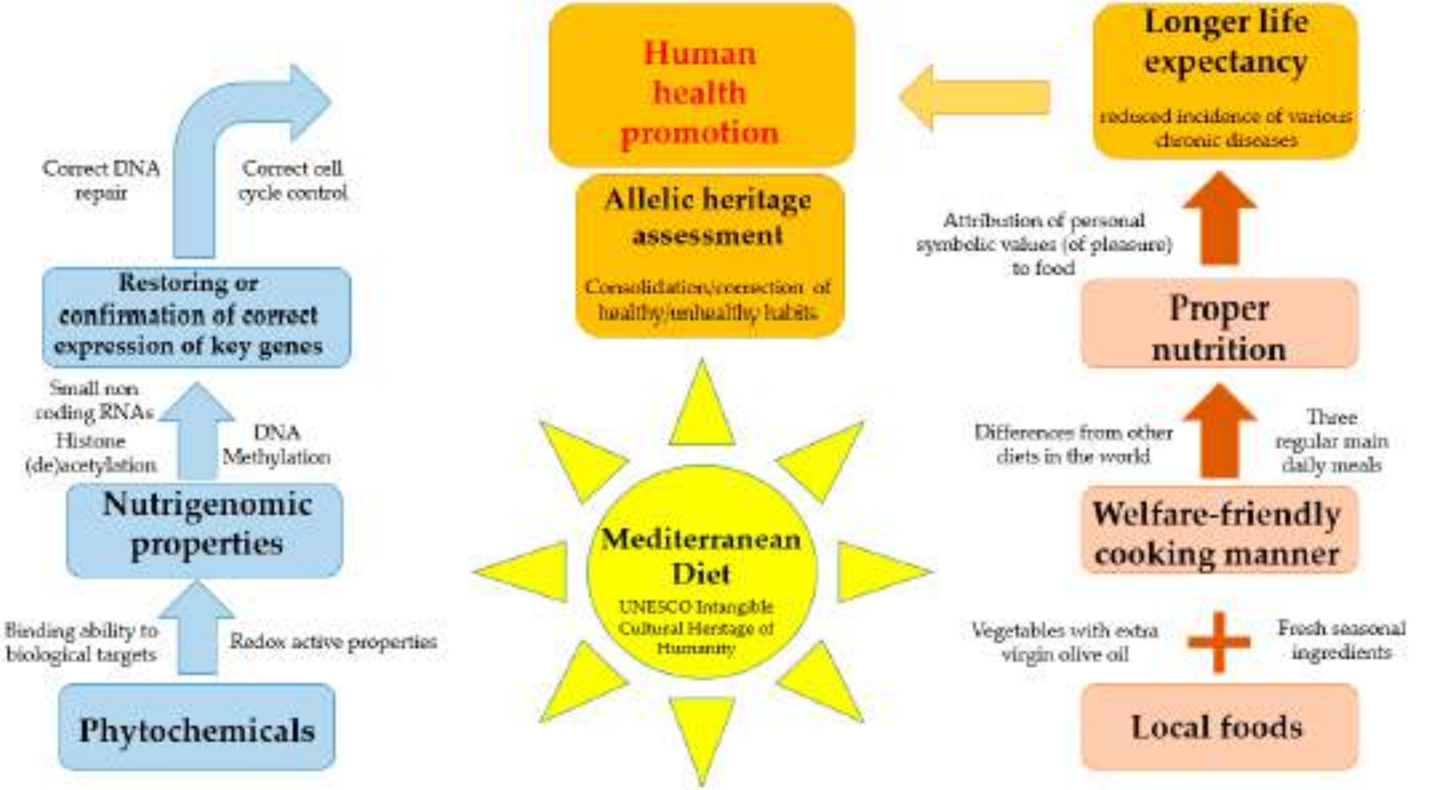

Figure 2. Patchwork expressing the "whole" concept of MD healthy properties. The left block of the diagram shows peculiar biological flowcharts; the right one displays selected non-biological points. The MD, interconnecting with both the blocks and taking advantage of an allelic assessment, represents a network promoting human health.

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Article

Mediterranean Personalized Diet Combined with Physical Activity Therapy for the Prevention of Cardiovascular Diseases in Italian Women

Laura Di Renzo [1,2,*,†], Giulia Cinelli [3,4,†], Maria Dri [5], Paola Gualtieri [1], Alda Attinà [3], Claudia Leggeri [3], Giuseppe Cennamo [6], Ernesto Esposito [7], Alberto Pujia [2], Gaetano Chiricolo [2], Chiara Salimei [8] and Antonino De Lorenzo [1]

Abstract: Cardiovascular diseases (CVDs) and inflammatory risk indexes are used to calculate the exposure to morbidity. Most of them are suggested by the American College of Cardiology/American Heart Association to predict the risk of CVDs diagnosis in primary prevention, instead of treating the ongoing pathology. Prevention starts from habit changes with the prescription of diet and physical activity (PA). The aim of the study is to investigate the effectiveness of a personalized Mediterranean Diet (MD) and a PA intervention, on the risk indexes Atherogenic Index of Plasma (AIP), Lipid Accumulation Product (LAP) and Fatty Liver Index (FLI) in a population of women at risk of CVDs with different pathological conditions. After treatment, patients achieved the best results in body composition (BC) and laboratory tests. The BC analysis showed a significant reduction of total body Fat Mass (FM). CVDs risk indexes significantly decreased, except for Neutrophil/Lymphocyte (NLR) and Platelet/Lymphocyte Ratios (PLR). The reduction of the CVDs indexes associated with lipid profile was linked to both weight and FM decrease. AIP and LAP were significantly reduced when losing fat mass and body weight, respectively. A personalized MD therapy plus a PA program led to body weight loss, BC remodelling and risk indexes reduction.

Keywords: cardiovascular disease; Mediterranean diet; non-communicable disease; obesity; physical activity

Nutrients 2020, 12, 3456; doi:10.3390/nu12113456 www.mdpi.com/journal/nutrients

Table 1. Anthropometric and body composition's characteristics at T0 and T1.

	T0	T1	*p*-Value *
Weight	88.4 ± 24.9	79.7 ± 18.7	<0.0001
BMI	32.3 ± 8.0	29.2 ± 6.0	<0.0001
Neck circumference	38.8 ± 4.4	37.1 ± 3.9	<0.0001
Waist circumference	98.6 ± 18.0	90.7 ± 13.6	<0.0001
Abdomen circumference	109.3 ± 19.6	100.0 ± 13.2	<0.0001
Hip circumference	113.3 ± 14.6	107.3 ± 11.1	<0.0001
WHR	0.869 ± 0.098	0.846 ± 0.093	0.0002
Rz	470 ± 79	468 ± 76	0.85
Xc	50 ± 10	52 ± 10	0.21
PA°	6.17 ± 1.11	6.38 ± 1.07	0.1
TBW (L)	42.6 ± 9.3	41.5 ± 8.6	0.004
TBW (%)	49.3 ± 7.3	52.4 ± 6.7	<0.0001
ECW (L)	19.2 ± 4.1	18.3 ± 3.7	0.003
ECW (%)	45.4 ± 5.0	44.5 ± 4.6	0.11
ICW (L)	23.4 ± 6.1	23.3 ± 5.8	0.8
ICW (%)	54.6 ± 5.0	55.5 ± 4.6	0.10
FM (kg)	36.75 ± 17.16	29.80 ± 12.24	<0.0001
FM (%)	40.3 ± 9.1	36.5 ± 8.8	<0.0001
LM (kg)	48.56 ± 10.71	47.42 ± 10.14	<0.0001
ASMMI	8.32 ± 1.82	8.06 ± 1.71	0.003

ASMMI, appendicular skeletal mass index; BMI, body mass index; ECW, Extra-Cellular Water; FM, fat mass; ICW, intracellular index; LM, lean mass; PA, Phase Angle; Rz, Resistance; TBW, Total Body Water; WHR, waist-to-hip ratio; Xc, Reactance. * The paired *t*-test and the Wilcoxon signed-rank test were performed in order to compare normal and skewed continuous variables, respectively, between pre- (T0) and post- (T1) treatment. Statistical significance for $p < 0.05$.

Table 2. Modification of risk markers after nutritional intervention and prescription of physical activity.

Cardiovascular Risk Indexes	T0	T1	*p* Value *
ASCVD risk	6.27 ± 7.21	2.84 ± 3.44	0.0001
NLR	1.73 ± 0.74	1.84 ± 0.57	0.31
PLR	116.24 ± 37.58	125.78 ± 65.29	0.29
Total cholesterol/cHDL	4.64 ± 1.38	3.50 ± 0.87	<0.0001
cLDL/cHDL	2.95 ± 1.09	2.12 ± 0.69	<0.0001
TG/cHDL	3.38 ± 2.53	1.89 ± 1.07	<0.0001
AIP	0.06 ± 0.27	−0.14 ± 0.22	<0.0001
FLI	59.74 ± 32.26	42.06 ± 30.73	<0.0001
LAP	58.66 ± 42.79	34.72 ± 23.43	<0.0001
BARD	3.42 ± 0.11	2.89 ± 0.23	0.06

ASCVD, Atherosclerotic Cardiovascular Diseases, AIP, Atherogenic Index of Plasma; BARD, (BMI, Alanine aminotransferase (ALT)/Aspartate aminotransferase (AST) ratio (AAR), Diabetes Mellitus (DM), cLDL/cHDL, low-density lipoprotein cholesterol-to-high density lipoprotein cholesterol ratio; FLI, Fatty Liver Index; LAP, Lipid Accumulation Product; NLR, neutrophils-to-lymphocytes ratio; PLR, platelets-to-lymphocytes ratio; Total cholesterol/cHDL, total cholesterol-to-high density lipoprotein cholesterol ratio; TG/cHDL, triglycerides-to-high density lipoprotein cholesterol ratio. * The paired t-test was performed to compare continuous variables between pre- (T0) and post- (T1) treatment. Statistical significance for $p < 0.05$.

nutrients

MDPI

Article

Potential Effects of a Modified Mediterranean Diet on Body Composition in Lipoedema

Laura Di Renzo [1,*,†], Giulia Cinelli [2,3,†], Lorenzo Romano [2], Samanta Zomparelli [2], Gemma Lou De Santis [2], Petronilla Nocerino [1], Giulia Bigioni [4], Lorenzo Arsini [4], Giuseppe Cenname [5], Alberto Pujia [6], Gaetano Chiricolo [6] and Antonino De Lorenzo [1]

Figure 1. Pictures of different stages of lipoedema. (**a**) Stage 1: the skin is still smooth and appears normal but with pain, bruising and nodules in the fat tissue. (**b**) Stage 2: the skin is characterized by a mattress-like pattern with the presence of fibrosis, development of nodular or mass-like appearance of the subcutaneous fat, lipomas and/or angiolipomas. (**c**): Stage 3 involves the loss in elasticity, inhibition of mobility, inflammation followed by constant and palpable fibrosis. (**d**) Stage 4: presence of both lipoedema and lymphoedema.

Table 1. *Cont.*

	LIPPY		CTRL	
	Baseline	mMeD	Baseline	mMeD
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Vit. A (μcg)	764.3 ± 329.7	1091.3 ± 71.2 *	930.6 ± 306	1281.2 ± 455.9 *
Vit. C (mg)	112 ± 48.5	190.2 ± 14.7 **	145.4 ± 62.20	224.5 ± 38.2 *
Vit. D (μcg)	4.3 ± 4.4	7.63 ± 2.5 *	2.3 ± 3.8	5.3 ± 2 *
Vit. E (mg)	11.7 ± 2.2	12.6 ± 2	5.3 ± 11.8	14.7 ± 1.6
ORAC (μmol)	2423.0 ± 1814.0	13538.0 ± 1517.0 **	11759.0 ± 6910.0	14105.0 ± 1584.0
MAI	1.4 ± 0.7	14.7 ± 0.7 **	1.45 ± 1.07	14.06 ± 1.9 **

SFA, saturated fatty acid; PUFA, polyunsaturated fatty acid; MUFA, monounsaturated fatty acid; EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid; Na, sodium; K, potassium; Fe, iron; Mg, magnesium; Vit., vitamin; ORAC, oxygen radical absorbance capacity; MAI, Mediterranean adequacy index; mMeD, modified Mediterranean diet therapy. The paired t-test was performed to compare dietary intake of the baseline diet and of the mMeD. * $p < 0.05$; ** $p < 0.0001$.

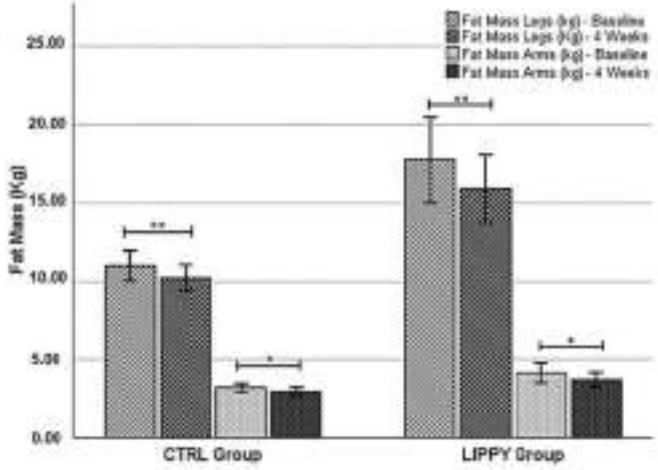

Figure 2. Differences between the baseline and after four weeks of the mMeD in each group for the legs' and arms' fat mass. Statistical significance was attributed as * $p < 0.05$; ** $p < 0.01$.

www.impactjournals.com/oncotarget/ Oncotarget, 2017, Vol. 8, (No. 5), pp: 8947-8979

Review

Impact of Mediterranean diet on metabolic syndrome, cancer and longevity

Nicola Di Daniele[1], Annalisa Noce[1], Maria Francesca Vidiri[3], Eleonora Moriconi[3], Giulia Marrone[1], Margherita Annicchiarico-Petruzzelli[3], Gabriele D'Urso[1], Manfredi Tesauro[1], Valentina Rovella[1], Antonino De Lorenzo[2]

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[2]Department of Biomedicine and Prevention, Division of Clinical Nutrition and Nutrigenomic, University of Rome "Tor Vergata", Italy

[3]Biochemistry Laboratory, IDI-IRCCS, Department of Experimental Medicine and Surgery, University of Rome "Tor Vergata", Italy

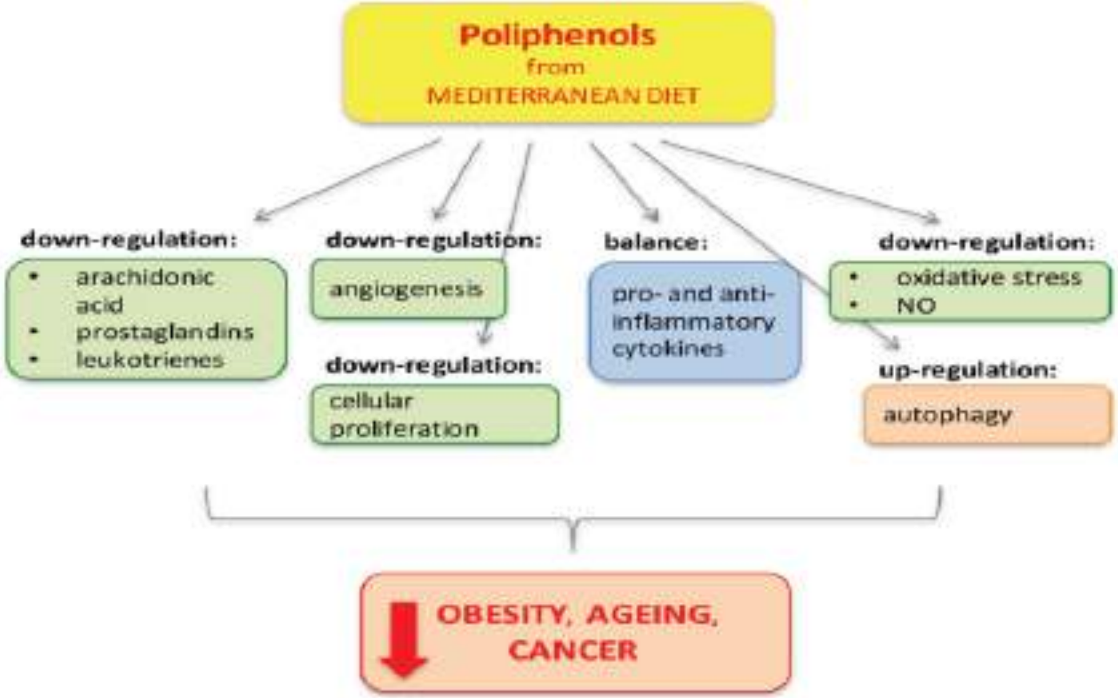

Figure 2: Polyphenols from Mediterranean Diet. Polyphenols protect and reduce inflammation by different pathways (through mechanisms of down-regulation, balance and up-regulation) preventing obesity, cancer and age-related diseases, in which inflammation has an important pathological role [240].

Mediterranean meal versus Western meal effects on postprandial ox-LDL, oxidative and inflammatory gene expression in healthy subjects: a randomized controlled trial for nutrigenomic approach in cardiometabolic risk

De Lorenzo A, Bernardini S, Gualtieri P, Cabibbo A, Perrone MA, Giambini I, Di Renzo L

Acta Diabetol (2017) 54: 141. doi:10.1007/s00592-016-0917-2

VS

Nutritional quality indices		
	Pasto McD	Pasto Mediterraneo
AI	1,97	0,17
TI	1,73	0,32

Baseline vs Mediterraneo

↓ **IRAK1** – chinasi 1 recettore interleuchina 1 associato
L'IRAK1 è parzialmente responsabile dell'eliminazione del fattore di trascrizione NF-kappa B indotta da IL1.

Baseline vs McD
↑ **IRAK1 –** chinasi 1 recettore interleuchina 1 associato
↑ **DUOX2 –** tiroide ossidasi 2
DUOX2 genera perossido di idrogeno.

McD vs Mediterraneo
↓**CCL5** – chemochina ligando 5
↓ **DUOX2 –** tiroide ossidasi 2

Current Pharmaceutical Design, 2010, 16, 000-000

The effects of Italian Mediterranean Organic Diet (IMOD) on Health Status

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Table 4. Laboratory Parameters in Healthy Subjects and in CKD Patients at T1 and T2

	Healthy Subjects					CKD Patients				
	T1		T2			T1		T2		
	Mean	SD	Mean	SD	P*	Mean	SD	Mean	SD	P*
Homocysteine(μM/L)	23.06	± 5.17	12.71	± 6.15	0.0106	22.12	± 5.17	17.81	± 5.29	0.0026
Azotemia (mg/dl)	33.20	± 11.33	30.66	± 8.51	NS	83.21	± 47.49	80.76	± 50.92	NS•
Creatinine (mg/dl)	0.88	± 0.29	0.95	± 0.18	NS	1.75	± 0.61	1.67	± 0.27	NS
Total Cholesterol (mg/dl)	167.02	± 60.55	189.66	± 36.21	NS	181.57	± 14.84	165.57	± 27.71	0.0369
HDL cholesterol (mg/dl)	33.04	± 12.30	39	± 6.86	NS	30.92	± 7.41	32.07	± 6.76	NS
Triglycerides (mg/dl)	98.44	± 47.56	113.44	± 26.70	NS	168.71	± 54.53	156.85	± 37.88	NS
Calcium (mg/dl)	9.64	± 0.16	9.43	± 0.37	NS	9.93	± 0.57	9.33	0.44	<0.0001
Phosphorus (mg/dl)	4.64	± 0.15	3.01	± 0.13	<0,0001	4.10	± 0.88	3.54	± 0.26	0.0382
Sodium (mEq/L)	140.97	± 0.86	139.51	± 1.11	0.0141	140.85	± 1.09	140.57	± 0.85	NS
Potassium (mEq/L)	4.34	± 0.15	4.31	± 0.39	NS	4.90	± 0.34	4.67	±0.65	NS
Glucose (mg/dl)	98.91	± 24.28	92.66	± 22.02	NS	86.78	± 6.71	90.23	±8.55	NS
Vitamin B_{12} (pg/ml)	217.33	± 20.10	259.11	± 22.65	0.0019	574.92	± 247.49	516.42	±195.42	NS
Microalbuminuria (mg/L)	-	-	-	-	-	93.55	± 121.9	71.7	±100.48	0.00286
hs-CRP (mg/dl)	0.44	±0.64	0.05	±0.01	0.001	5.63	±4.82	4.51	±4.94	<0.001

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Journal of Translational Medicine

RESEARCH Open Access

Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey

Laura Di Renzo[1†], Paola Gualtieri[1†], Francesca Pivari[2*], Laura Soldati[2], Alda Attinà[2], Giulia Cinelli[3,4], Claudia Leggeri[2], Giovanna Caparello[3], Luigi Barrea[5], Francesco Scerbo[6], Ernesto Esposito[7] and Antonino De Lorenzo[1]

Table 3 Positive answers to MEDAS questionnaire and adherence to the MD

	Whole sample (n = 3533)	Northern Italy (n = 547)	Center Italy (n = 2009)	Southern Italy and Islands (n = 977)
Olive oil, main dressing	3368 (95.8)	*518 (94.7)*	*1940 (96.6)*	928 (95.0)
Olive oil, >= 4 ts/day	*1827 (51.7)*	257 (47.0)	*1076 (53.6)*	494 (50.6)
Vegetables, >= 2 s/day	*2430 (68.8)*	*398 (72.8)*	*1396 (69.5)*	636 (65.1)
Fruits, >= 3 s/day	1202 (34.0)	180 (32.9)	666 (33.2)	356 (36.4)
Read meat, < 1 s/day	*1854 (52.5)*	*307 (56.1)*	*1039 (51.7)*	508 (52.0)
Butter, < 1 s/day	1668 (47.2)	301 (55.0)	888 (44.2)	479 (49.0)
Sweet beverage, < 1 s/day	1676 (47.4)	293 (53.6)	916 (45.6)	467 (47.8)
Wine, 7 s/week	396 (11.2)	60 (11.0)	245 (12.2)	91 (9.3)
Legumes, >= 3 s/week	*1826 (51.7)*	267 (48.8)	966 (48.1)	*593 (60.7)*
Fish and seafood, >= 3 s/week	1376 (38.9)	198 (36.2)	750 (37.3)	428 (43.8)
Sweets, < 3 s/week	1753 (49.6)	*280 (51.2)*	970 (48.3)	*503 (51.5)*
Nuts, >= 3/week	1675 (47.4)	281 (51.4)	909 (45.2)	485 (49.6)
White meat over red	*2653 (75.1)*	*427 (78.1)*	*1575 (75.4)*	*711 (72.8)*
"Soffritto"	*1890 (53.5)*	*309 (56.5)*	*1067 (53.1)*	*514 (52.6)*
MEDAS score	7 [6–9]*	7 [6–9]	7 [6–9]	7 [6–9]
Adherence to the MD				
Low	765 (21.7)	108 (19.7)	463 (23.0)	194 (19.9)
Medium	2228 (63.1)	344 (62.9)	1261 (62.8)	623 (63.8)
High	540 (15.3)	95 (17.4)	285 (14.2)	160 (16.4)

Positive answers to MEDAS questionnaire. Compliance rates of at least 50% are indicated in italics. Data are expressed as number and percentage in parenthesis (n (%)) for categorical variables or median and IQR in square brackets (M [IQR]) for continuous variables. Vegetables daily serving: 1 medium portion = 200 g. Fruit daily serving: 1 serving = 100–150 g portion. Red meat/hamburgers/other meat daily serving: 1 medium portion = 100–150 g. Butter, margarine or cream daily serving: 1 medium portion = 12 g. Sweet or sugar sweetened carbonated beverages daily serving: 1 medium portion = 200 ml. Wine daily serving: 1 medium portion = 125 ml. Legumes weekly serving: 1 portion = 150 g. Fish daily serving: 1 medium portion = 100–150 g. Seafood daily serving: 1 medium portion = 200 g. Nuts weekly serving: 1 portion of dairy product = 30 g

MEDAS Mediterranean diet adherence screener; *MD* Mediterranean diet; *s* serving; *ts* tablespoon

*The Shapiro–Wilk test was performed to evaluate variables distribution. Variables are considered non-normally distributed for $p < 0.05$

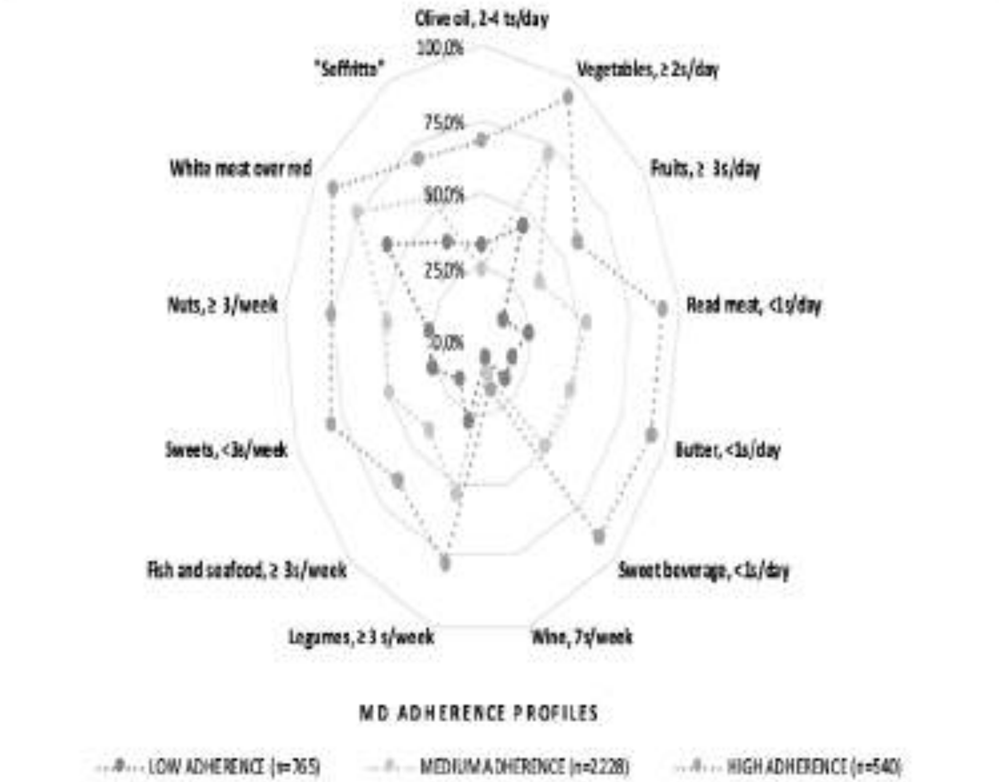

Fig. 3 Compliance with items from MEDAS according to high, medium and low adherence to the Mediterranean diet (MD). The radar chart plots the values of each item of MEDAS score along a separate axis that starts in the centre of the chart (0% compliance) and ends at the outer ring (100% compliance). The values are the percentage of the population adherent to each recommendation.

nutrients

MDPI

Review

Role of Personalized Nutrition in Chronic-Degenerative Diseases

Laura Di Renzo [1], Paola Gualtieri [1,*], Lorenzo Romano [2], Giulia Marrone [3,4], Annalisa Noce [4], Alberto Pujia [5], Marco Alfonso Perrone [6], Vincenzo Aiello [7], Carmela Colica [8] and Antonino De Lorenzo [1]

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Abstract: Human nutrition is a branch of medicine based on foods-biochemical interactions with the human body. The phenotypic transition from health to disease status can be attributed to changes in genes and/or protein expression. For this reason, a new discipline has been developed called "-omic science". In this review, we analyzed the role of "-omics sciences" (nutrigenetics, nutrigenomics, proteomics and metabolomics) in the health status and as possible therapeutic tool in chronic degenerative diseases. In particular, we focused on the role of nutrigenetics and the relationship between eating habits, changes in the DNA sequence and the onset of nutrition-related diseases. Moreover, we examined nutrigenomics and the effect of nutrients on gene expression. We perused the role of proteomics and metabolomics in personalized nutrition. In this scenario, we analyzed also how dysbiosis of gut microbiota can influence the onset and progression of chronic degenerative diseases. Moreover, nutrients influencing and regulating gene activity, both directly and indirectly, paves the way for personalized nutrition that plays a key role in the prevention and treatment of chronic degenerative diseases.

Keywords: nutrigenetic; nutrigenomic; personalized nutrition; epigenetic; Mediterranean diet; obesity; gut microbiota

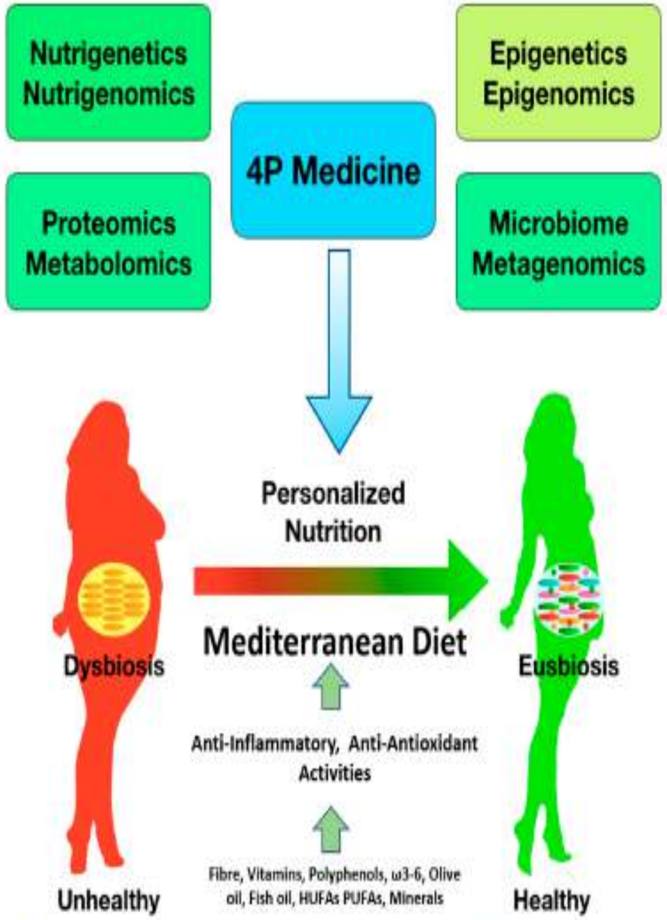

Figure 1. 4P medicine, in the era of -omics sciences; to switch from an unhealthy condition of dysbiosis to a healthy condition of eusbiosis. 4P: Predictive, personalized, preventive and participatory; HUFAs: h-3 highly unsaturated fatty acids; PUFAs: polyunsaturated fatty acids.

The knowledge acquired from the sequencing of human genomes has led to the consolidation of a new molecular dimension of medicine, in particular, known as the field of "predictive medicine". By using the unique genetic information that can be obtained in each individual, this approach is capable of anticipating the estimated risk of developing certain diseases in a subject's lifetime [15].

“Sustainability revolution”


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https://doi.org/10.1007/s13197-019-04155-0

REVIEW ARTICLE

Conceptual evolution and scientific approaches about synthetic meat

Alice Munz Fernandes[1] · Odilene de Souza Teixeira[2] · Jean Philippe Palma Revillion[3] · Ângela Rozane Leal de Souza[1]

J Food Sci Technol (June 2020) 57(6):1991–1999 1995

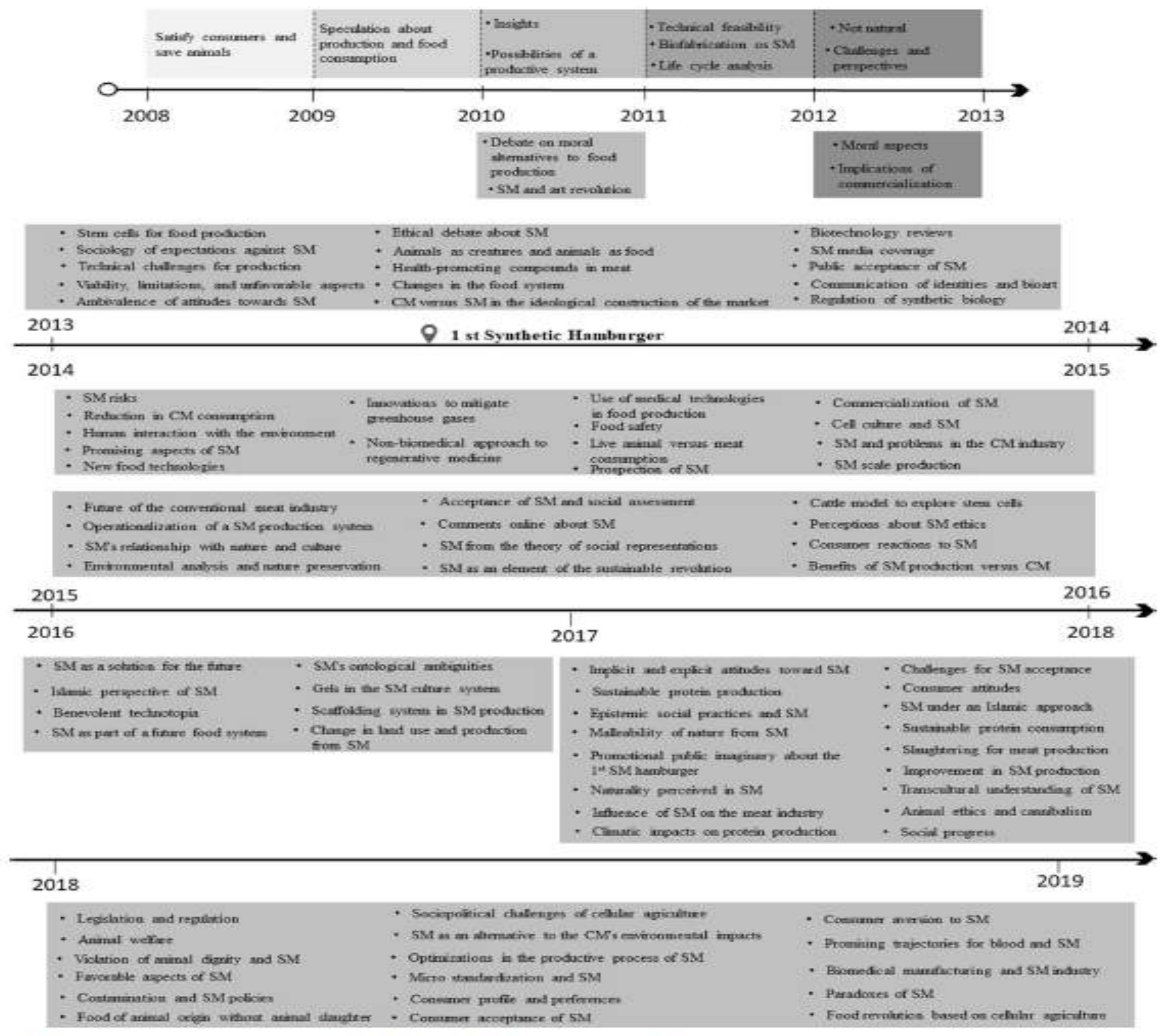

Fig. 3 Timeline containing the central focus of the publications on synthetic meat

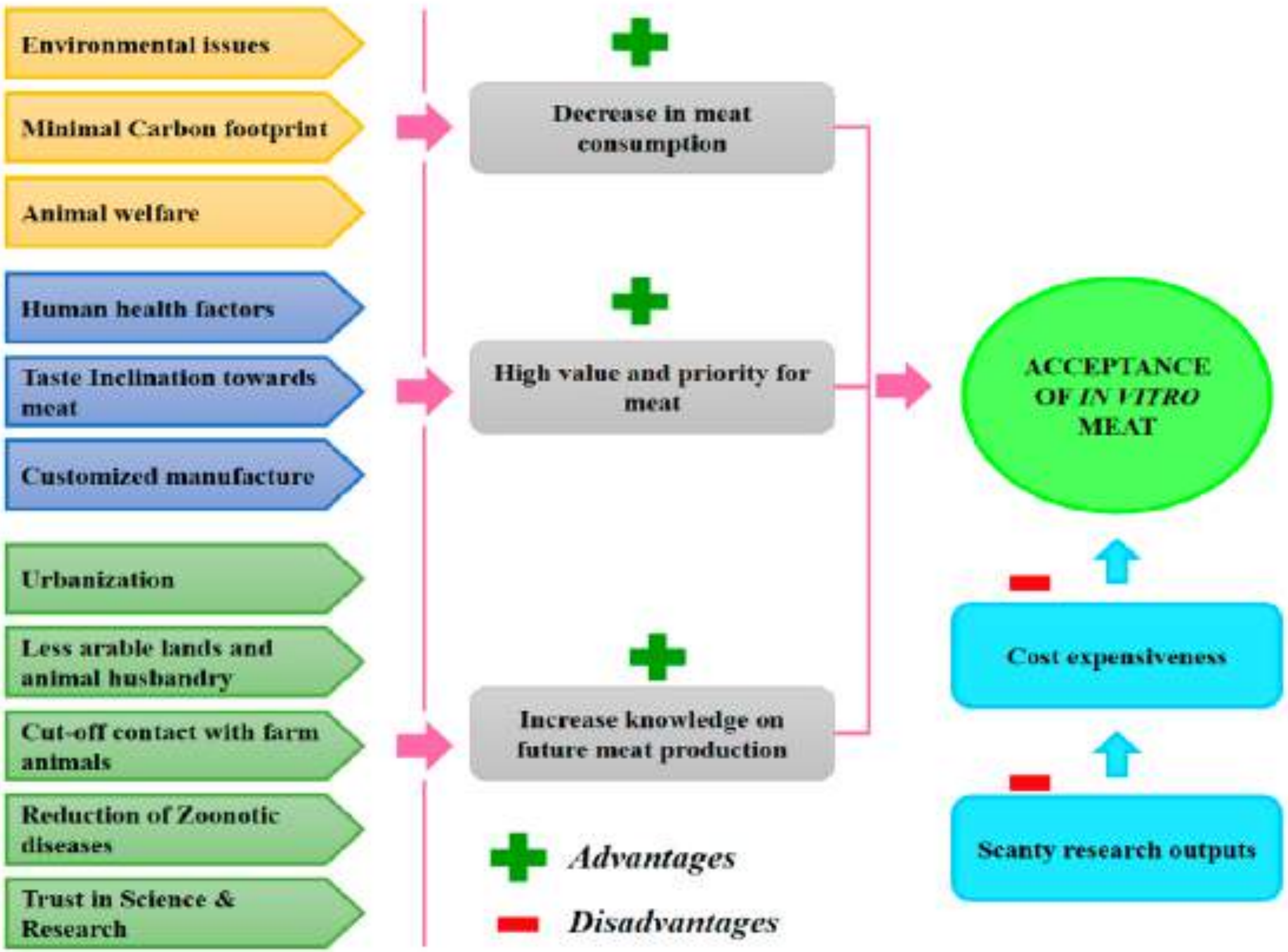

Figure 3. The agenda underpinning the promotion and acceptance of artificial meat.

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foods

Review

The Epic of In Vitro Meat Production—A Fiction into Reality

Balamuralikrishnan Balasubramanian [1], Wenchao Liu [2], Karthika Pushparaj [3] and Sungkwon Park [1,*]

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Abstract: Due to a proportionally increasing population and food demands, the food industry has come up with wide innovations, opportunities, and possibilities to manufacture meat under in vitro conditions. The amalgamation of cell culture and tissue engineering has been the base idea for the development of the synthetic meat, and this has been proposed to be a pivotal study for a futuristic muscle development program in the medical field. With improved microbial and chemical advancements, in vitro meat matched the conventional meat and is proposed to be eco-friendly, healthy, nutrient rich, and ethical. Despite the success, there are several challenges associated with the utilization of materials in synthetic meat manufacture, which demands regulatory and safety assessment systems to manage the risks associated with the production of cultured meat. The role of 3D bioprinting meat analogues enables a better nutritional profile and sensorial values. The integration of nanosensors in the bioprocess of culture meat eased the quality assessment throughout the food supply chain and management. Multidisciplinary approaches such as mathematical modelling, computer fluid dynamics, and biophotonics coupled with tissue engineering will be promising aspects to envisage the future prospective of this technology and make it available to the public at economically feasible rates.

Citation: Balasubramanian, B.; Liu, W.; Pushparaj, K.; Park, S. The Epic of In Vitro Meat Production—A Fiction

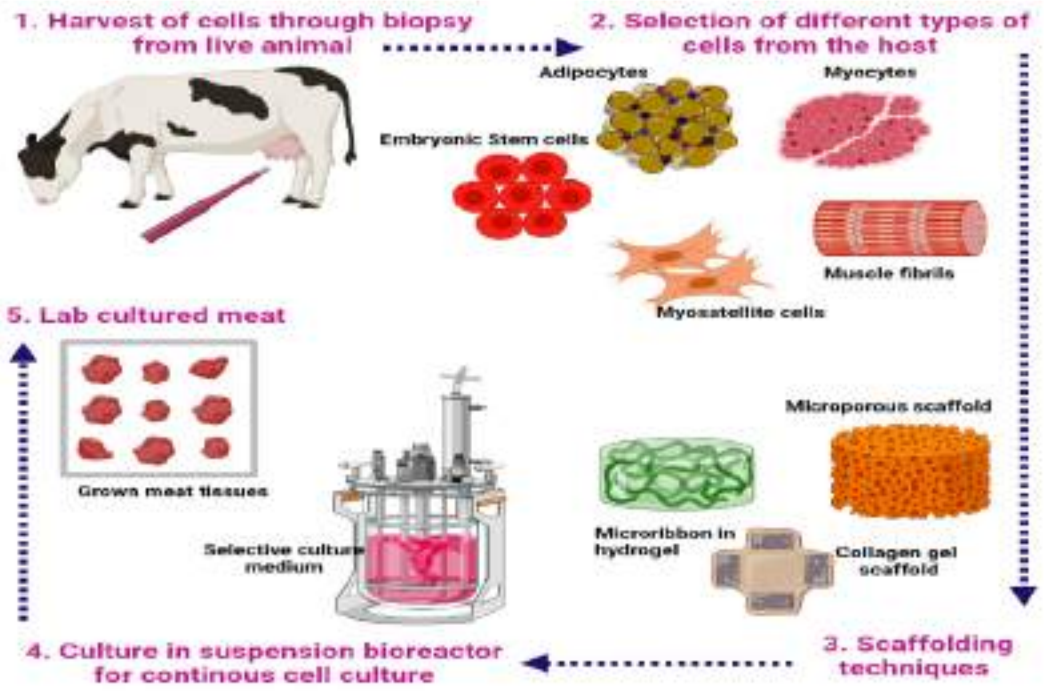

Figure 1. A pipeline for the production of illustrating the common stages involved in the production of a cultured meat product.

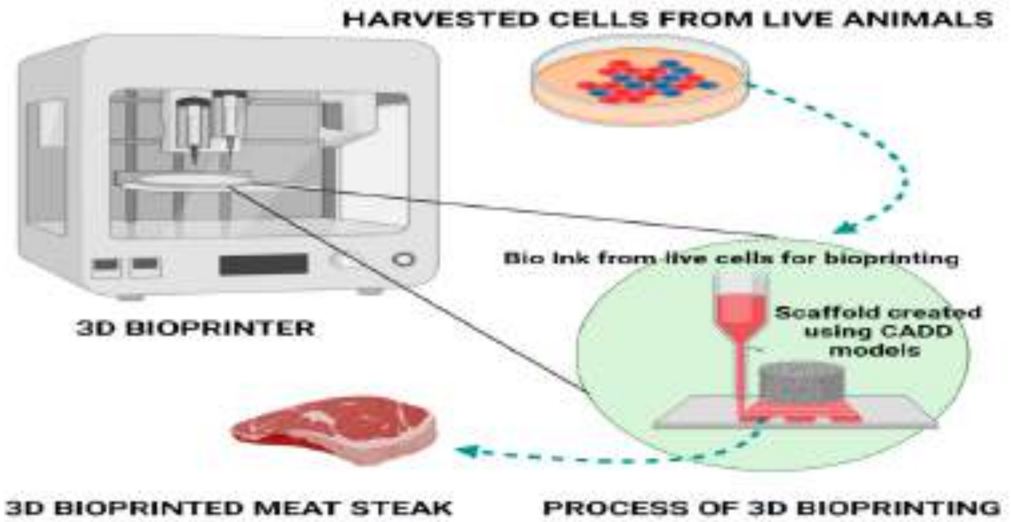

Figure 4. The trans-disciplinary application of 3D bioprinting in in vitro culture meat technique.

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'Would you eat cultured meat?': Consumers' reactions and attitude formation in Belgium, Portugal and the United Kingdom

Wim Verbeke [a], Afrodita Marcu [b], Pieter Rutsaert [a c], Rui Gaspar [d e], Beate Seibt [d f], Dave Fletcher [g], Julie Barnett [h]

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Abstract

Cultured meat has evolved from an idea and concept into a reality with the August 2013 cultured hamburger tasting in London. Still, how consumers conceive cultured meat is largely an open question. This study addresses consumers' reactions and attitude formation towards cultured meat through analyzing focus group discussions and online deliberations with 179 meat consumers from Belgium, Portugal and the United Kingdom. Initial reactions when learning about cultured meat were underpinned by feelings of disgust and considerations of unnaturalness. Consumers saw few direct personal benefits but they were more open to perceiving global societal benefits relating to the environment and global food security. Both personal and societal risks were framed in terms of uncertainties about safety and health, and possible adverse societal consequences dealing with loss of farming and eating traditions and rural livelihoods. Further reflection pertained to skepticism about 'the inevitable' scientific progress, concern about risk governance and control, and need for regulation and proper labeling.

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ARTICLE

A Comparative Study on the Taste Characteristics of Satellite Cell Cultured Meat Derived from Chicken and Cattle Muscles

Seon-Tea Joo[1,2], Jung-Suk Choi[3], Sun-Jin Hur[4], Gap-Don Kim[5], Chan-Jin Kim[1], Eun-Yeong Lee[1], Allah Bakhsh[1], and Young-Hwa Hwang[2,*]

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Abstract This study investigated the amino acid and nucleotide-related compound composition and taste characteristics of cultured muscle tissue (CMT) obtained by culturing satellite cells isolated from chicken and cattle and compared them to those of traditional meat (TM). The content of all amino acids except valine and tyrosine was significantly different between CMT and TM ($p<0.05$). The amount of glutamic acid was not significantly different between CMT and TM in cattle, but the glutamic acid in chicken CMT was lower than that of TM ($p<0.05$). Among the nucleotide-related compounds, only the content of inosine-5'-monophosphate (IMP) was significant, and the amount of IMP in CMT derived from chicken and cattle was significantly lower than that of TM ($p<0.05$). There were significant differences in the taste characteristics assessed by an electronic tongue system, and the umami, bitterness, and sourness values of CMT were significantly lower than those of TM from both chicken and cattle ($p<0.05$). The results of the present study suggest that it is necessary to develop a satellite cell culture method that could increase the umami and bitterness intensity of CMT and adjust the composition of the growth medium to produce cultured meat with a taste similar to that of TM.

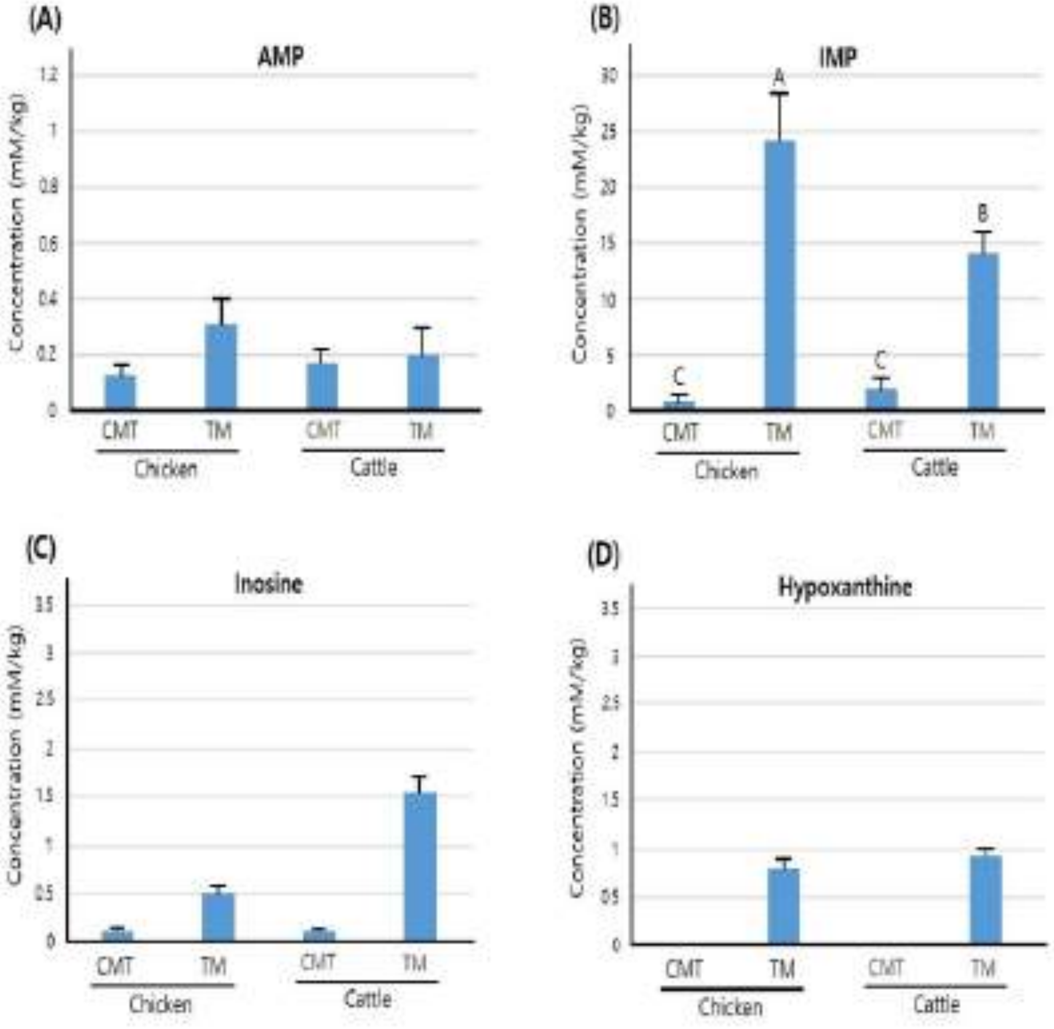

Fig. 2. Differences in nucleotide-related compounds composition between cultured muscle tissues (CMT) derived from chicken and cattle and traditional meat (TM). A–C Means with different superscripts in the same graph are significantly different ($p<0.05$).

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Table 1. Differences in amino acid composition between cultured muscle tissue derived from chicken and cattle and traditional meat

Amino acids	Chicken		Cattle		SEM	p-value	Contrast		
	CMT	TM	CMT	TM			Meat	Animal	Meat×Anim
Aspartic acid	9.37^{B}	9.93^{A}	8.59^{C}	9.76^{AB}	0.156	<0.001	<0.001	<0.001	0.009
Glutamic acid	15.42^{B}	17.30^{A}	14.56^{B}	15.89^{AB}	0.635	0.004	0.002	0.014	0.467
Threonine	4.51^{A}	4.79^{A}	3.60^{B}	4.96^{A}	0.180	<0.001	<0.001	0.008	<0.001
Serine	4.93^{A}	4.23^{BC}	4.61^{AB}	3.95^{C}	0.156	<0.001	<0.001	0.010	0.776
Proline	5.73^{A}	3.78^{B}	6.64^{A}	3.60^{B}	0.371	<0.001	<0.001	0.127	0.034
Glycine	7.91^{A}	5.02^{B}	7.68^{A}	4.98^{B}	0.390	<0.001	<0.001	0.565	0.614
Alanine	6.88^{B}	6.41^{C}	7.92^{A}	6.53^{BC}	0.174	<0.001	<0.001	<0.001	0.001
Cysteine	0.43^{B}	0.57^{B}	1.47^{A}	0.54^{B}	0.085	<0.001	<0.001	<0.001	<0.001
Valine	4.71	4.55	4.93	4.76	0.206	0.240	0.204	0.109	0.989
Methionine	1.80^{B}	2.44^{AB}	3.49^{A}	2.52^{AB}	0.474	0.015	0.015	0.012	0.019
Isoleucine	3.75^{B}	4.49^{A}	3.32^{C}	4.52^{A}	0.110	<0.001	<0.001	0.013	0.006
Leucine	7.75^{B}	8.63^{A}	7.35^{B}	9.02^{A}	0.246	<0.001	<0.001	0.991	0.023
Tyrosine	3.64	3.91	3.58	3.95	0.232	0.201	0.044	0.961	0.701
Phenylalanine	4.57^{A}	4.82^{A}	3.68^{B}	4.78^{A}	0.280	0.003	0.003	0.020	0.030
Histidine	2.38^{B}	2.79^{B}	2.83^{B}	3.98^{A}	0.180	<0.001	<0.001	<0.001	0.007
Lysine	8.46^{B}	9.50^{A}	7.43^{C}	9.73^{A}	0.297	<0.001	<0.001	0.046	0.006
Arginine	7.70^{B}	6.81^{C}	8.28^{A}	6.45^{C}	0.153	<0.001	<0.001	0.243	<0.001

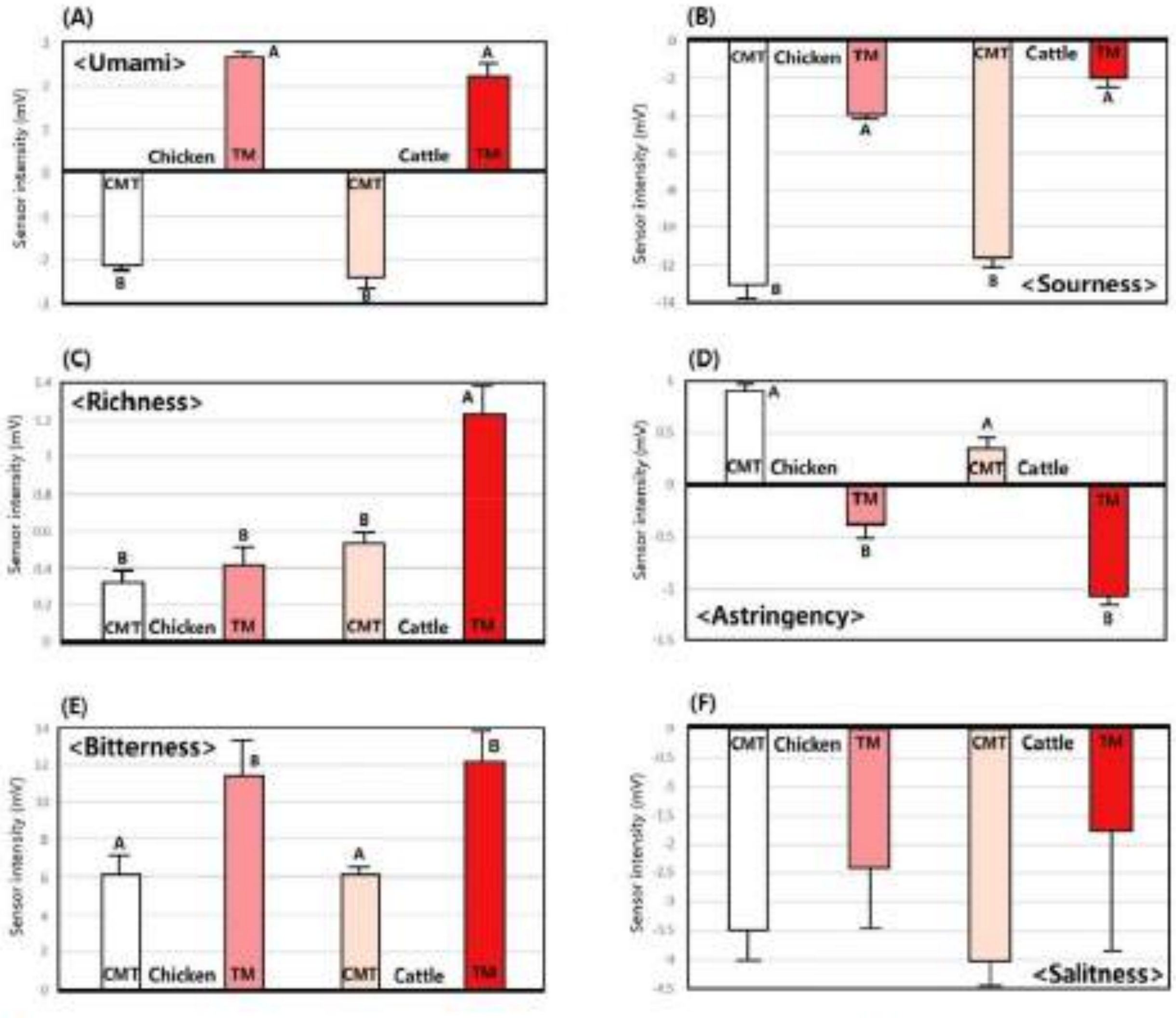

Fig. 3. Differences in taste characteristics assessed by electronic tongue system between cultured muscle tissues (CMT) derived from chicken and cattle and traditional meats (TM). ^{A,B} Means with different superscripts in the same graph are significantly different (p<0.05).

International Journal of *Molecular Sciences*

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Review

Cell Sources for Cultivated Meat: Applications and Considerations throughout the Production Workflow

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Abstract: Cellular agriculture is an emerging scientific discipline that leverages the existing principles behind stem cell biology, tissue engineering, and animal sciences to create agricultural products from cells in vitro. Cultivated meat, also known as clean meat or cultured meat, is a prominent subfield of cellular agriculture that possesses promising potential to alleviate the negative externalities associated with conventional meat production by producing meat in vitro instead of from slaughter. A core consideration when producing cultivated meat is cell sourcing. Specifically, developing livestock cell sources that possess the necessary proliferative capacity and differentiation potential for cultivated meat production is a key technical component that must be optimized to enable scale-up for commercial production of cultivated meat. There are several possible approaches to develop cell sources for cultivated meat production, each possessing certain advantages and disadvantages. This review will discuss the current cell sources used for cultivated meat production and remaining challenges that need to be overcome to achieve scale-up of cultivated meat for commercial production. We will also discuss cell-focused considerations in other components of the cultivated meat production workflow, namely, culture medium composition, bioreactor expansion, and biomaterial tissue scaffolding.

Keywords: cellular agriculture; cultivated meat; cell sourcing; stem/progenitor cells; primary cells; skeletal muscle tissue engineering

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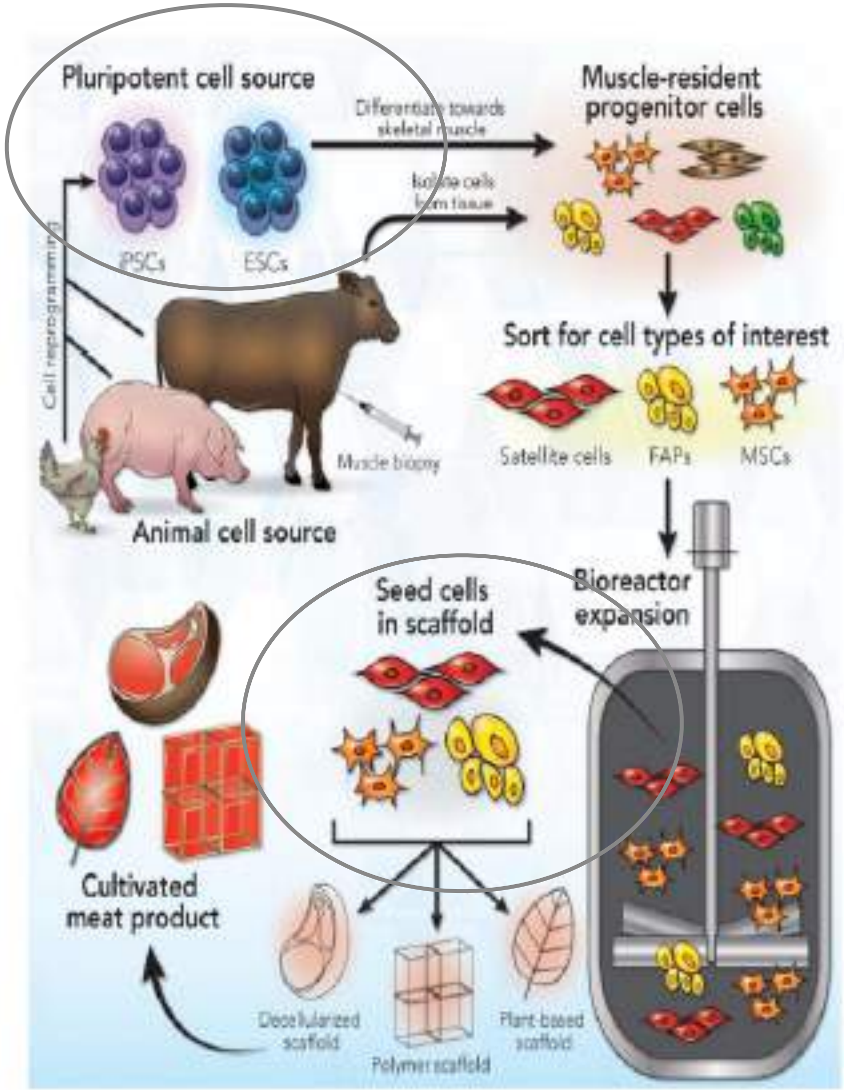

Figure 1. General workflow for cultivated meat production. The first step is cell sourcing, which may be either an animal cell source or pluripotent cell source. Relevant cell types from the chosen cell source are then isolated and expanded in a bioreactor to yield a large quantity of cells. Finally, the cells are matured in a biocompatible tissue scaffold that supports cell development and provides the cultivated meat product with a specific structure.

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Table 1. Overview of relevant cell types for cultivated meat production and methods to obtain them.

Cell Source	Relevant Cell Types	Location of Cell Type In Vivo	Method to Obtain	Proliferative Capacity	Differentiation Potential	Cell Type Markers	Isolated from Relevant Species
Adult stem cells	Muscle satellite cells	Beneath basement membrane of skeletal myotubes	Muscle biopsy	Limited	Skeletal myotubes	Pax7 M-cadherin Syndecan-4 CXCR4 α-7 integrin VCAM-1 CD56	Bovine [18] Galline [19] Ovine [20] Piscine [21] Porcine [22]
	Mesenchymal stem/stromal cells (MSCs)	Numerous locations (ex. bone marrow, umbilical cord, skeletal muscle, adipose tissue)	Tissue biopsy	Limited	Adipocytes Chondrocytes Fibroblasts	CD105 CD73 CD90 Sca-1 PDGFRα	Bovine [23–25] Galline [26] Ovine [27] Porcine [28]
	Fibro-adipogenic progenitors (FAPs)	Interstitial space of skeletal muscle	Muscle biopsy	Limited	Adipocytes Fibroblasts	Sca-1 PDGFRα	Bovine [29,30] Porcine [31,32]
Pluripotent stem cells	Embryonic stem cells (ESCs)	Inner cell mass of blastocyst	Isolate from inner cell mass	Indefinite	Any cell type	Oct4 Sox2 Nanog c-Myc Klf4	Bovine [33] Galline [34] Ovine [35] Piscine [36,37] Porcine [38]
	Induced pluripotent stem cells (iPSCs)	N/A	Somatic cell reprogramming - Overexpression of pluripotent transcription factors - Small-molecule-mediated reprogramming	Indefinite	Any cell type	Oct4 Sox2 Nanog c-Myc Klf4	Bovine [39] Galline [40,41] Ovine [42] Porcine [43]

Table 2. Overview of advancements and current limitations in the cultivated meat production workflow.

Production Component	Advancements/Benefits	Limitations
Cell source	+ Pluripotent and adult stem cell sources applicable + Isolation and sorting protocols established for agriculturally relevant species	- Cost and ease of obtaining cell type is inversely proportional to the proliferative capacity and potential of the cell type - Limited expansion capability in vitro for adult stem cells - Low iPSC reprogramming yield and possible phenotypic side effects from reprogramming - Ethical sourcing of ESCs
Culture medium	+ Well-developed expansion and differentiation medium for relevant cell types + Development of several xeno-free medium formulations	- Xeno-free medium is still not as effective as medium with serum - Key growth factors needed are expensive
Bioreactor	+ Several media introduction and recycling options + Permits dynamic cell culture + Improves cell expansion and differentiation + Allows significantly larger cell quantities to be cultured	- Further scale-up needed - Energy expensive - Some dynamic culture methods may damage cells
Scaffold	+ Provides anchorage to enable and/or improve cell differentiation + Enables tailored cell distribution and localization + Microcarriers may improve taste and texture of the final meat product + 3D bioprinting enables tailored architecture and material distribution	- Nutrient and oxygen diffusion limited at larger scaffold sizes - Requirements for biocompatibility and edibility limit biomaterial options

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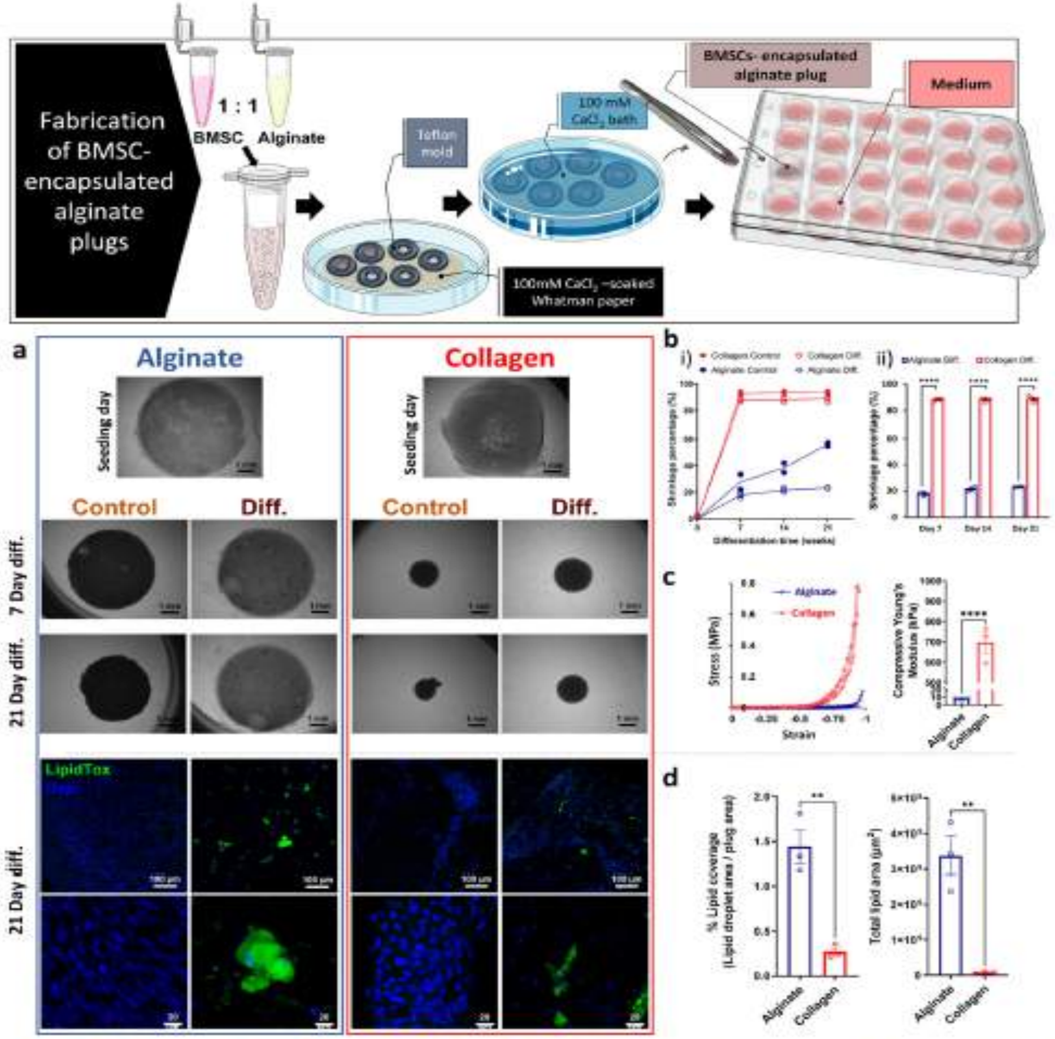

Fig. 2 Influence of matrix material on engineered adipose tissue formation. Top panel: Illustration of BMSC-loaded alginate plug fabrication. Image credits: this figure was created using elements from Servier Medical Art (https://smartservier.com). **a** (top panel) Bright-field images of BMSC-loaded alginate and BMSC-loaded collagen constructs cultured in differentiation medium (diff.) or standard medium (control), as captured on seeding day, and after 7, 14, and 21 days of differentiation, scale bar 1 mm. **b** Shrinkage percentage of the constructs (relative to their original size) (i) All samples: differentiation or control in alginate or in collagen over 21 days of differentiation, (ii) BMSC-loaded alginate vs. BMSC-loaded collagen constructs after 7, 14, and 21 days in differentiation medium $n = 4$. **c** Compressive stress-strain curves and calculated Young's modulus of BMSC-loaded alginate vs. BMSC-loaded collagen constructs after 21 days in differentiation medium, $n = 3$, Student's *t*-test, error bars show SE, $^{****}p < 0.0001$. **a** (bottom panel) Confocal laser scanning microscopy images (green, LipidTox; blue, DAPI) of BMSC-loaded alginate and BMSC-loaded collagen constructs cultured in differentiation medium or in standard medium, for 21 days, scale bars: 100 µm (top) and 20 µm (bottom). **d** Quantified lipid droplet coverage and total lipid area of LipidTox-stained differentiated alginate vs. collagen constructs, $n = 3$, Student's *t*-test, error bars show SE, $^{**}p < 0.01$.

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biology

ARTICLE

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Engineered marble-like bovine fat tissue for cultured meat

Yedidya Zagury[1], Iris Ianovici[1], Shira Landau[1], Neta Lavon[2] & Shulamit Levenberg[1,2]✉

Cultured meat can provide a sustainable and more ethical alternative to conventional meat. Most of the research in this field has been focused on developing muscle tissue, as it is the main component of meat products, while very few studies address cultured fat tissue, an essential component in the human diet and determinant of meat quality, flavor, juiciness, and tenderness. Here, we engineered bovine fat tissue for cultured meat and incorporated it within engineered bovine muscle tissue. Mesenchymal stem cells (MSCs) were derived from bovine adipose tissue and exhibited the typical phenotypic profile of adipose-derived MSCs. MSC adipogenic differentiation and maturation within alginate-based three-dimensional constructs were optimized to yield a fat-rich edible engineered tissue. Subsequently, a marble-like construct, composed of engineered bovine adipose and muscle tissues, was fabricated, mimicking inter- and intra-muscular fat structures.

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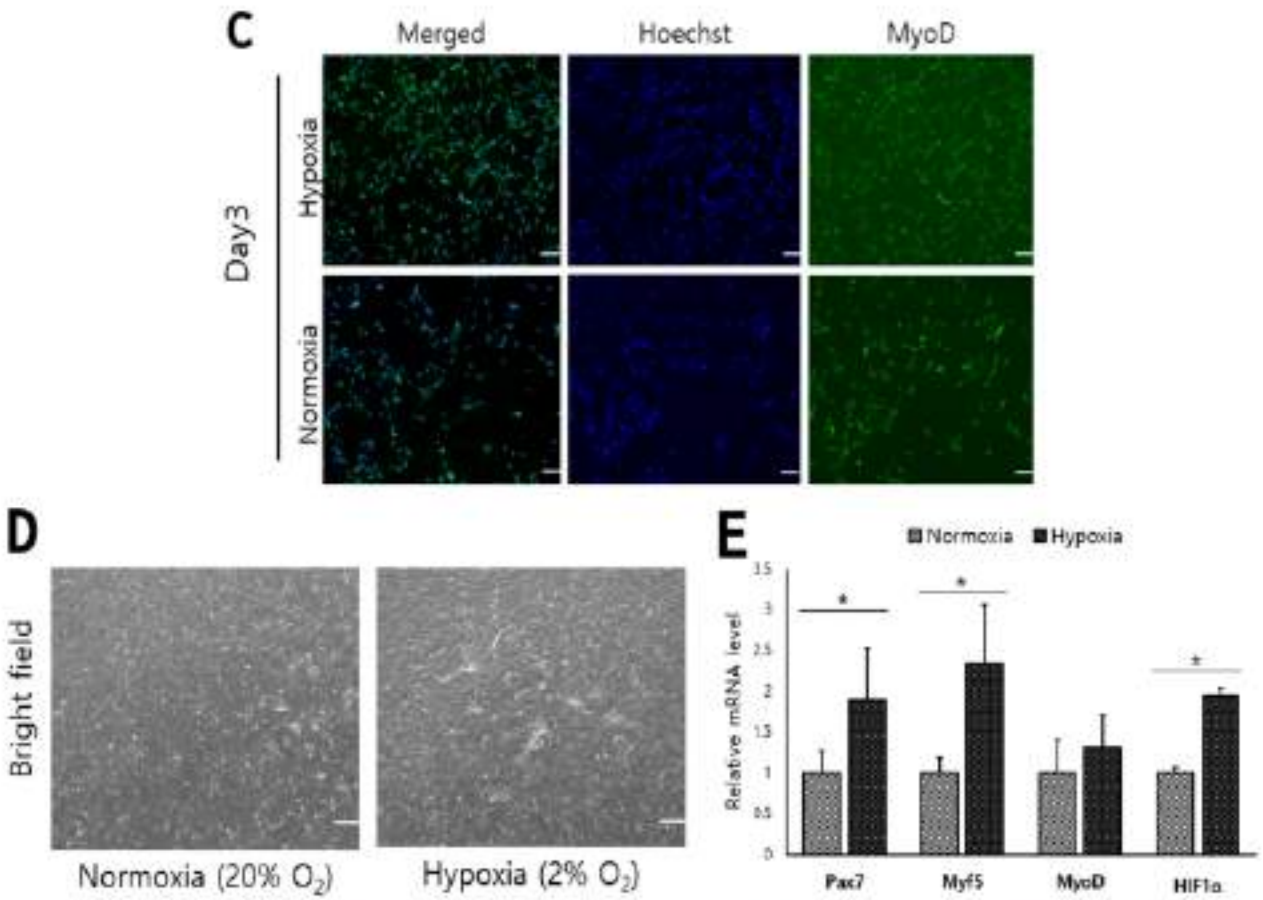

Figure 4. The cell nuclei stained with Hoechst (Hoechst 33,342 nucleic acid stain) were blue fluorescence and Pax7 and MyoD proteins were stained with green fluorescence. **(A)**: The nuclei and MyoD protein of Hanwoo myosatellite cells cultured for 1 day in hypoxia (2% O_2) and normoxia (20% O_2) were stained. **(B,C)**: The nuclei, Pax7 and MyoD protein of Hanwoo myosatellite cells cultured for 3 days in hypoxia (2% O_2) and normoxia (20% O_2) were stained. Experiments were performed in triplicate and repeated three times (* $p < 0.05$). Hanwoo myosatellite cells were seeded in T25 flasks at 1800 cells/cm^2 and cultured in GM for 6 days in normoxia (20% O_2) or hypoxia (2% O_2) **(D)**. **(E)**: Relative Pax7, Myf5, MyoD and HIF1α mRNA levels were compared in Hanwoo myosatellite cells from (D). GAPDH was used as an internal control for RT-PCR. scale bar: 100 µm.

biomolecules MDPI

Article

Effects of Hypoxia on Proliferation and Differentiation in Belgian Blue and Hanwoo Muscle Satellite Cells for the Development of Cultured Meat

Sanghun Park [1], Mick Gagliardi [2,3], Geertje Swennen [2,3], Arin Dogan [2], Yuna Kim [1], Yunhwan Park [1], Gyutae Park [1], Sehyuk Oh [1], Mark Post [2,3,*] and Jungseok Choi [1,*]

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Abstract: Among future food problems, the demand for meat is expected to increase rapidly, but the production efficiency of meat, which is a protein source, is very low compared to other foods. To address this problem, research on the development and production of cultured meat as an alternative meat source using muscle stem cells in vitro has recently been undertaken. Many studies have been conducted on myosatellite cells for medical purposes, but studies on alternative meat production are rare. In vitro cell culture mimics the in vivo environment for cell growth. The satellite cell niche is closer to hypoxic (2% O_2) than normoxic (20% O_2) conditions. The aim of this study was to investigate the efficient oxygen conditions of myosatellite cell cultures for the production of cultured meat. The bovine satellite cell counts and mRNA (Pax7, Myf5 and HIF1α) levels were higher in hypoxia than normoxia ($p < 0.05$). Through Hoechst-positive nuclei counts, and expression of Pax7, MyoD and myosin protein by immunofluorescence, it was confirmed that muscle cells performed normal proliferation and differentiation. Myoblast fusion was higher under hypoxic conditions ($p < 0.05$), and the myotube diameters were also thicker ($p < 0.05$). In the myotube, the number of cells was high in hypoxia, and the expression of the total protein amounts, differentiation marker mRNA (myogenin, myosin and TOM20), and protein markers (myosin and TOM20) was also high. The study results demonstrated that the proliferation and differentiation of bovine myosatellite cells were promoted more highly under hypoxic conditions than under normoxic conditions. Therefore, hypoxic cultures that promote the proliferation and differentiation of bovine myosatellite cells may be an important factor in the development of cultured meat.

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Can Cultured Meat Be an Alternative to Farm Animal Production for a Sustainable and Healthier Lifestyle?

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Producing animal proteins requires large areas of agricultural land and is a major source of greenhouse gases. Cellular agriculture, especially cultured meat, could be a potential alternative for the environment and human health. It enables meat and other agricultural products to be grown from cells in a bioreactor without being taken from farm animals. This paper aims at an interdisciplinary review of literature focusing on potential benefits and risks associated with cultured meat. To achieve this goal, several international databases and governmental projects were thoroughly analyzed using keywords and phrases with specialty terms. This is a growing scientific domain, which has generated a series of debates regarding its potential effects. On the one hand the potential of beneficial effects is the reduction of agricultural land usage, pollution and the improvement of human health. Other authors question if cultured meat could be a sustainable alternative for reducing gas emissions. Interestingly, the energy used for cultured meat could be higher, due to the replacement of some biological functions, by technological processes. For potential effects to turn into results, a realistic understanding of the technology involved and more experimental studies are required.

Keywords: cultured meat, health, greenhouse gases, bioreactor, animal welfare

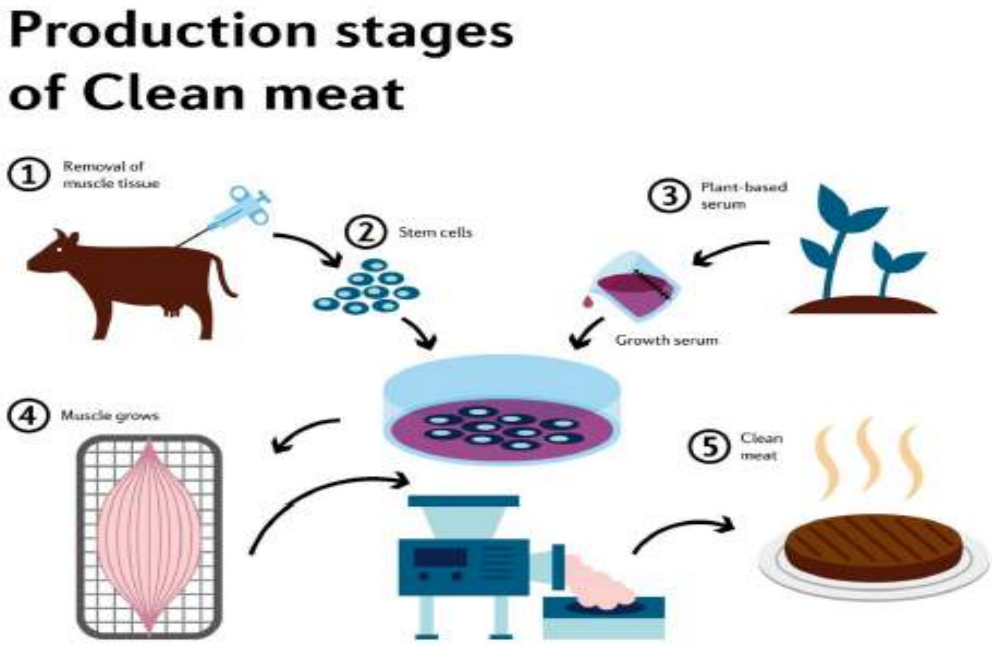

FIGURE 1 | Culture meat cycle. Source: (9). 1- non-invasive uptake of stem cells from cows; 2 and 3 represent the steps in which cell culture takes place in a cultured environment to grow and divide; 4 - differentiation of cells tissues that are identical to the one harvested from the animal; 5-meat processing in order to reach the consumer directly.

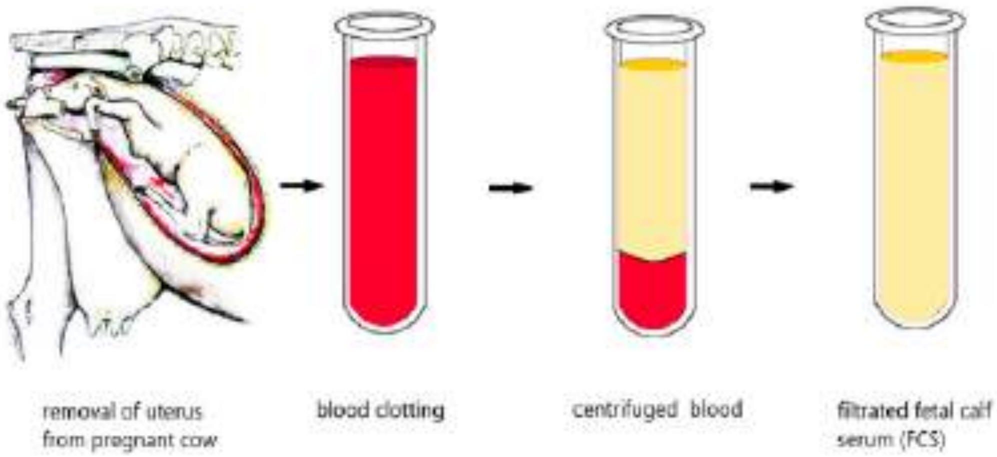

FIGURE 6 | The obtaining of fetal bovine serum (original) this is taken by sacrificing a pregnant cow and draining the blood from the fetus's heart, which obviously has not been anesthetized.

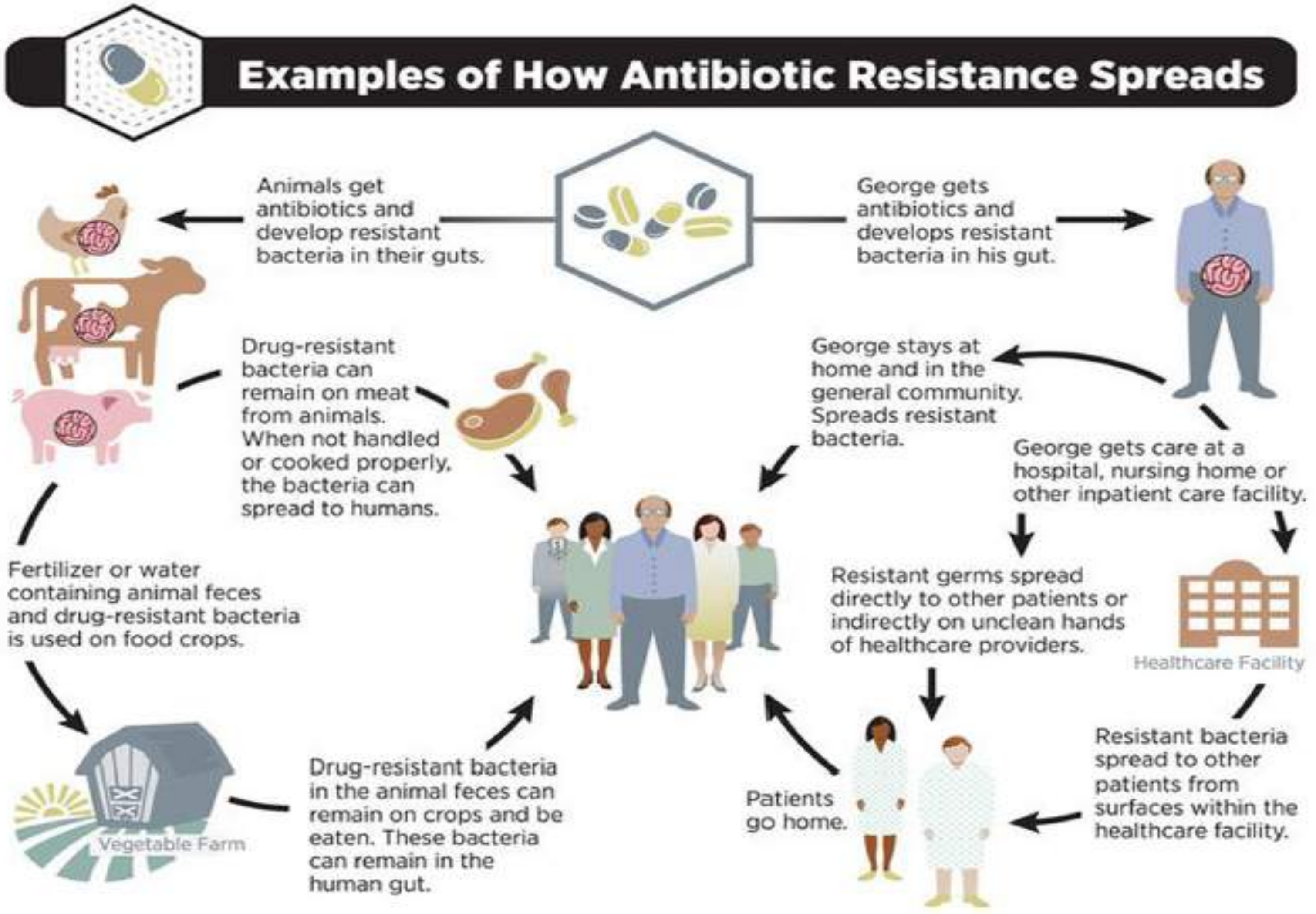

FIGURE 9 | Antibiotic Resistance Spreads. Source: (86). The large use of antibiotics represents the most important factor leading to world antibiotic resistance; For prevention, control, and treatment of disease, and also to promote growth they are commonly used in food-producing animals; For the treatment of plant crops against bacterial infections antibiotics are used in very small amounts.

Come la carne coltivata può imitare le caratteristiche nutrizionali di quella da allevamento animale?

La qualità della carne coltivata

Il gusto della vera carne è influenzato dalle condizioni di lavorazione post mortem, come le condizioni di conservazione e la macellazione. È importante menzionare il fatto che il la trasformazione metabolica dopo la morte è rappresentata dal tessuto ipossia. Il risultato è una diminuzione del pH intracellulare. Inoltre, il pH acido è responsabile della perdita di acqua.

Non ci sono studi riguardanti la qualità del metabolismo post mortem della carne coltivata

- Il gusto e la consistenza sono legati alla specificità nutrizionale degli animali.
- Se l'animale ha **un'attività fisica più intensa, la carne è molta più ricca di proteine e povera di grassi**. I
- La distribuzione del le fibre muscolari di tipo I o di tipo II dipendono dall'attività fisica che determinati soggetti svolgono. Questa transizione può essere prodotta in presenza di **Vitamina B3**.
- **La differenza tra fibre muscolari di tipo I o di tipo II è anche legata al metabolismo del ferro.**
- I grassi sono responsabili dell'esaltatore di buon sapore per le carni. Attraverso l'ossidazione, gli acidi grassi possono produrre composti carbonilici che sono potenti contributori di sapore. Composti volatili rilasciati dal grasso possono essere responsabile dei sapori specifici della specie di manzo, maiale. Quindi, da questo punto di vista, alcuni acidi grassi come **acido linoleico e l'acido docosaesaenoico sono sintetizzati attraverso bioidrogenazione specifica da l'intestino** o le alghe dei ruminanti, non da adipociti in coltura.

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animal

Review: Analysis of the process and drivers for cellular meat production

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Cell-based meat, also called 'clean', lab, synthetic or in vitro meat, has attracted much media interest recently. Consumer demand for cellular meat production derives principally from concerns over environment and animal welfare, while secondary considerations include consumer and public health aspects of animal production, and food security. The present limitations to cellular meat production include the identification of immortal cell lines, availability of cost-effective, bovine-serum-free growth medium for cell proliferation and maturation, scaffold materials for cell growth, scaling up to an industrial level, regulatory and labelling issues and at what stage mixing of myo-, adipo- and even fibrocytes can potentially occur. Consumer perceptions that cell-based meat production will result in improvements to animal welfare and the environment have been challenged, with the outcome needing to wait until the processes used in cell-based meat are close to a commercial reality. Challenges for cell-based meat products include the simulation of nutritional attributes, texture, flavour and mouthfeel of animal-derived meat products. There is some question over whether consumers will accept the technology, but likely there will be acceptance of cell-based meat products, in particular market segments. Currently, the cost of growth media, industry scale-up of specific components of the cell culture process, intellectual property sharing issues and regulatory hurdles mean that it will likely require an extended period for cellular meat to be consistently available in high-end restaurants and even longer to be available for the mass market. The progress in plant-based meat analogues is already well achieved, with products such as the Impossible™ Burger and other products already available. These developments may make the development of cellular meat products obsolete. But the challenges remain of mimicking not only the nutritional attributes, flavour, shape and structure of real meat, but also the changes in regulation and labelling.

Keywords: lab meat, environment, health, consumer, animal welfare

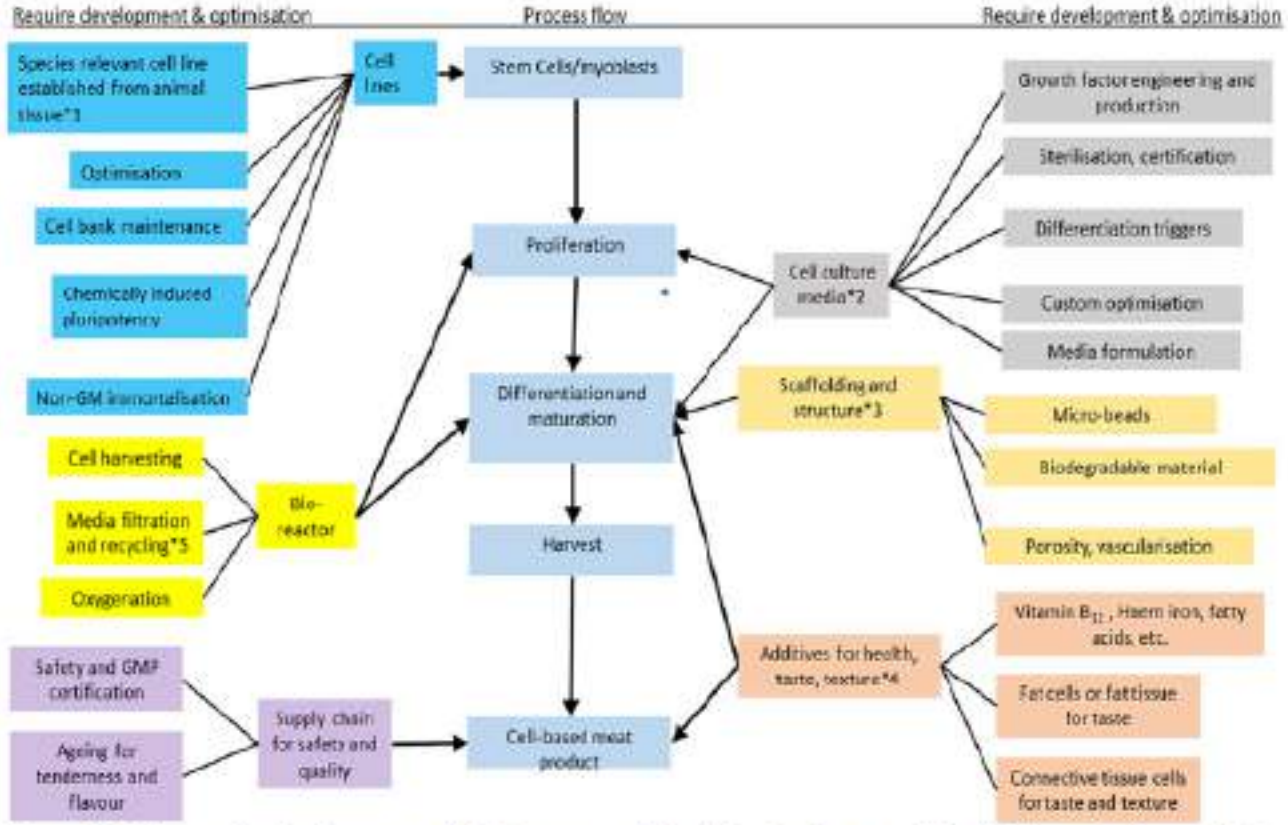

Figure 3 (Colour online) Diagram showing the stages of cellular meat production including the process flow (blue boxes in the centre), the components requiring research, development and optimisation on the extreme left and right and the critical decision points marked by an asterisk (*). Choices which are important decision points for both small scale and industrial production include: (1) source of tissue to derive cells from, (2) growth media to stimulate differentiation, proliferation, formation of myotubes and maturation of adipocytes and muscle cells, (3) scaffold or matrix on which cells can grow, (4) when to add nutrients or fat tissue/cells in order to simulate sensory and nutrient attributes of whole muscle, (5) whether to recycle water and nutrients for growth medium. *Source*: Adapted from Specht *et al.* (2018) and Bhat *et al.* (2019).

Il piano HACCP dovrà specificare l'audit per l'identificazione di tutti i possibili agenti patogeni, la possibile contaminazione fisica e la sicurezza delle sostanze chimiche aggiunte, compresi i metodi per prevenire la contaminazione in ogni fase di produzione, il monitoraggio e della qualità in ogni fase, i test di stabilità genetica

frontiers in Nutrition

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The Myth of Cultured Meat: A Review

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To satisfy the increasing demand for food by the growing human population, cultured meat (also called *in vitro*, artificial or lab-grown meat) is presented by its advocates as a good alternative for consumers who want to be more responsible but do not wish to change their diet. This review aims to update the current knowledge on this subject by focusing on recent publications and issues not well described previously. The main conclusion is that no major advances were observed despite many new publications. Indeed, in terms of technical issues, research is still required to optimize cell culture methodology. It is also almost impossible to reproduce the diversity of meats derived from various species, breeds and cuts. Although these are not yet known, we speculated on the potential health benefits and drawbacks of cultured meat. Unlike conventional meat, cultured muscle cells may be safer, without any adjacent digestive organs. On the other hand, with this high level of cell multiplication, some dysregulation is likely as happens in cancer cells. Likewise, the control of its nutritional composition is still unclear, especially for micronutrients and iron. Regarding environmental issues, the potential advantages of cultured meat for greenhouse gas emissions are a matter of controversy, although less land will be used compared to livestock, ruminants in particular. However, more criteria need to be taken into account for a comparison with current meat production. Cultured meat will have to compete with other meat substitutes, especially plant-based alternatives. Consumer acceptance will be strongly influenced by many factors and consumers seem to dislike unnatural food. Ethically, cultured meat aims to use considerably fewer animals than conventional livestock farming. However, some animals will still have to be reared to harvest cells for the production of *in vitro* meat. Finally, we discussed in this review the nebulous status of cultured meat from a religious point of view. Indeed, religious authorities are still debating the question of whether *in vitro* meat is *Kosher* or *Halal* (e.g., compliant with Jewish or Islamic dietary laws).

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POSITIVO

- Senza organi digestivi nelle vicinanze (nonostante il fatto che la carne convenzionale è generalmente protetta), e quindi senza alcuna potenziale contaminazione al momento della macellazione, le cellule muscolari in coltura non hanno la possibilità di essere contaminate da agenti patogeni intestinali come E. coli, Salmonella o Campylobacter, tre agenti patogeni responsabili milioni di episodi di malattia ogni anno.

- La carne coltivata non è prodotta da animali allevati in uno spazio ristretto, quindi si elimina il rischio di un focolaio di malattie trasmissibili e non ce n'è bisogno costose vaccinazioni.

- La resistenza agli antibiotici è nota come uno dei maggiori problemi per l'allevamento di bestiame

NEGATIVO

- ✓ Gli scienziati o i produttori non sono mai nella posizione di poter controllare tutto: qualsiasi errore o svista può avere conseguenze drammatiche in caso di un problema di salute. Questo si verifica frequentemente al giorno d'oggi durante la produzione industriale di Carne tritata.

- ✓ Sono le cellule, non gli animali, che vivono in numero elevato in incubatrici per produrre carne coltivata.Il processo di coltura cellulare non è mai perfettamente controllato e possono sempre veirificarsi alcuni meccanismi biologici inattesi. Ad esempio, dato il gran numero di moltiplicazioni cellulari in atto, è probabile che si verifichi una certa disregolazione delle linee cellulari, come accade nelle cellule tumorali. Ciò potrebbe avere effetti potenziali sconosciuti sulla struttura muscolare e possibilmente sul metabolismo umano e sulla salute

- ✓ Gli antibiotici vengono aggiunti per prevenire qualsiasi contaminazione, anche occasionalmente per interromperla precocemente e ridurre possibili inquinamenti cellulari

L'aggiunta di sostanze chimiche al mezzo rende carne coltivata un cibo più "chimico». Sono necessarie con etichetta più chiare

- **Il contenuto nutrizionale della carne coltivata può essere controllato regolando i composti grassi utilizzati nel mezzo di produzione.**

➢ Il rapporto tra acidi grassi saturi e acidi grassi polinsaturi può essere facilmente controllato. I grassi saturi possono essere sostituiti da altri tipi di grassi, come gli omega-3, ma il rischio di **maggiore irrancidimento deve essere controllato**.

❖ **L'effetto di qualsiasi (micro)nutriente può essere potenziato se introdotto in una opportuna matrice.**

➢ Nel caso della carne in vitro, non è certo che gli altri composti biologici e il modo in cui sono organizzati nelle cellule in coltura possano potenziare gli effetti positivi dei micronutrienti sulla salute umana.

➢ **Nessuna strategia è stata sviluppata per dotare la carne coltivata di determinati micronutrienti specifici per prodotti di origine animale** (come **vitamina B12 e ferro**)

➢ L' **assorbimento di micronutrienti (come il ferro) da cellule in coltura deve quindi essere compreso meglio.**

➢ Non possiamo escludere una **riduzione degli effetti benefici dei micronutrienti per la salute dovuti al**

frontiers in Nutrition

CONCEPTUAL ANALYSIS
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Sensorial and Nutritional Aspects of Cultured Meat in Comparison to Traditional Meat: Much to Be Inferred

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Cultured meat aspires to be biologically equivalent to traditional meat. If cultured meat is to be consumed, sensorial (texture, color, flavor) and nutritional characteristics are of utmost importance. This paper compares cultured meat to traditional meat from a tissue engineering and meat technological point of view, focusing on several molecular, technological and sensorial attributes. We outline the challenges and future steps to be taken for cultured meat to mimic traditional meat as closely as possible.

Keywords: post-mortem metabolism, texture, flavor, color, nutritional composition, cultivated meat, clean meat

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INTRODUCTION

In 2013, the first cultured meat prototype in the shape of a hamburger was presented in the media (1). The hamburger was based on 10,000 strips containing myotubes engineered in a hydrogel. However, the engineered muscle-like tissues also required the addition of colorants (beetroot juice), flavors (saffron and caramel), and texturizers (bread crumbs and a binder) to make the patty similar in appearance to a hamburger (2). Producing a high-quality hamburger from traditional meat does not require the addition of these ingredients, suggesting that the intrinsic characteristics of the cultured cells differed significantly from traditional meat. The tasting panel commented that the burger tasted a little dry due to a lack of fat, but no profound quality or sensorial assessment was performed. The only other, modest, sensorial test on cultured cells reported in scientific literature, dates back to the early years of cultured meat experimentation and included smelling and observation, but no tasting (3). In addition, several review papers briefly discussed the potential sensorial characteristics of cultured meat (or derived products) (4, 5), but most of the information provided was based on indirect assumptions and on knowledge of the current *in vitro* production capabilities. To our knowledge, a scientific and technological comparison between cultured meat and traditional meat has not been published thus far. This relates to the fact that cultured meat is currently not available in sufficient quantities to conduct, such assessments. Still, based on the currently available state of the art concerning the production process of cultured meat, important considerations with regard to the technological, sensorial and nutritional characteristics of cultured meat can be inferred.

Cultured meat aspires to be biologically equivalent to traditional meat (6). If cultured meat is to be consumed, sensorial characteristics (texture, color, flavor) are of utmost importance. These sensorial properties are derived from the molecular characteristics of the product, such as the content and nature of the proteins, the presence of myoglobin, the composition of volatile compounds, etc. In addition to sensorial attributes, the nutritional quality of cultured meat should also resemble its traditional counterpart as closely as possible. Traditional meat is a nutritionally

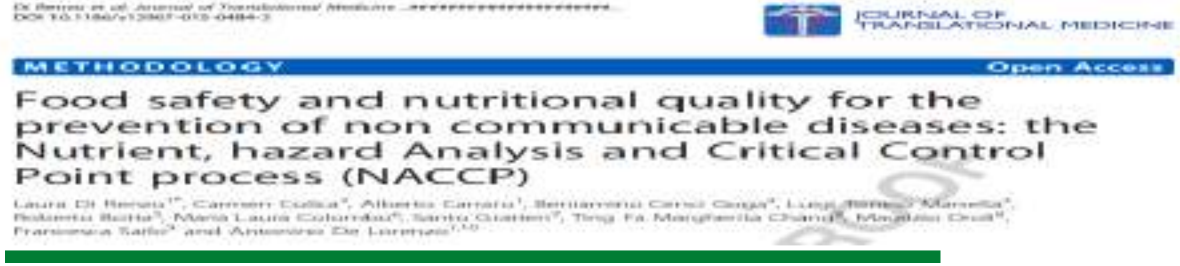
METABOLISMO POST-MORTEM

Quando un animale da fattoria viene macellato, i muscoli si trasformano in carne attraverso un complesso processo biochimico

STRUTTURA E SAPORE

A causa dell'assenza di sangue, fornendo solo nutrienti e ossigeno con perfusione limitata, si possono ottenere solo alcuni strati cellulari, rendendo il prodotto simile a carne sminuzzata o macinata, somigliante a hamburger lavorati industrialmente, molto lontani dagli hamburger freschi di alta qualità

LA COLTIVAZIONE DI CARNE POTREBBE ESSERE PIU' UTILE PER PRODURRE PROTEINE SINTETICHE


METHODOLOGY
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Food safety and nutritional quality for the prevention of non communicable diseases: the Nutrient, hazard Analysis and Critical Control Point process (NACCP)

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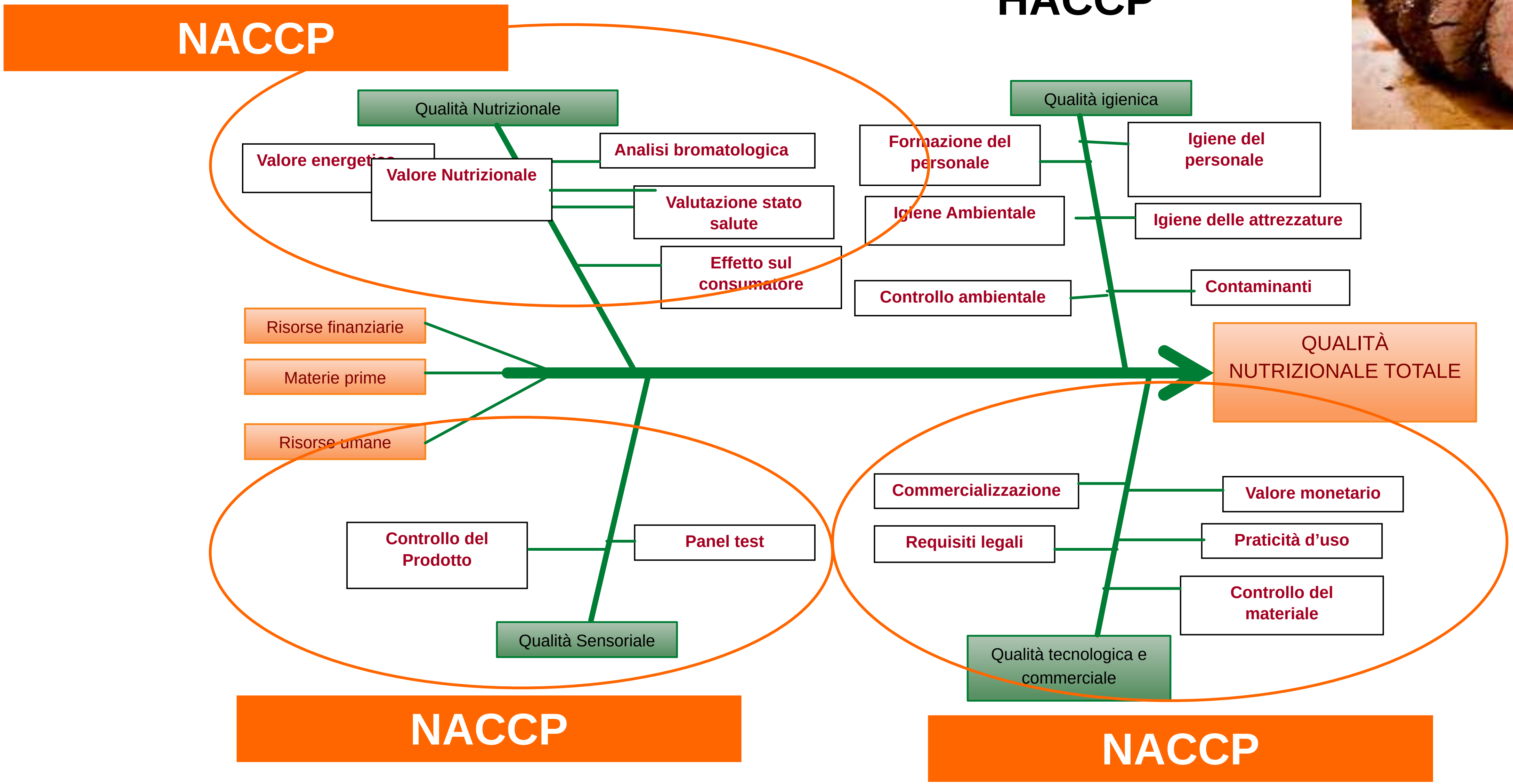
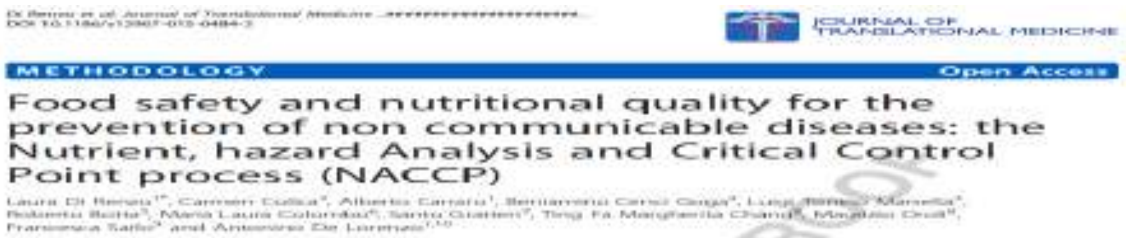
HACCP

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HACCP
identificazione dei punti critici di controllo

NACCP
identificazione dei punti critici di controllo

Rischio igienico-sanitario: contaminazione fisica, chimica, microbiologica

Rischio perdita nutriente nella filiera

VERIFICA DELLA QUALITA' NUTRIZIONALE

GAP
Good
Agricolture
Pratics

GEP
Good
Environmentale
Pratics

GMP
Good
Manufacting
Pratics

GLP
Good
Laboratory
Pratics

GHP
Good Hygiene
Pratics

GKP
Good
Housekeeping
pratics

GNP
Good Nutritional Pratics

Monitoraggio: valutazione dei rischi

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Ad ogni step produttivo, il processo NACCP valuta il rischio di contaminazione con pericolo per la sicurezza del consumatore e il rischio di poter perdere il biomarcatore nutrizionale di interesse. Per capire la gravità è necessario applicare un calcolo del rischio che identifica in maniera univoca tale possibilità e può indirizzare gli operatori del settore all'adozione di specifiche azioni correttive per poter ridurre tale possibilità. Il criterio di analisi del rischio nutrizionale è basato sulla probabilità che una fase, particolarmente delicata, possa far diminuire o perdere la qualità nutrizionale dell'alimento

Rischio (R)= Probabilità (P) x Danno (D)

$\Sigma\ R(p_{a,b,c\ldots\ n+1})$

P4	**4**	**8**	**12**	**16**
P3	**3**	**6**	**9**	**12**
P2	**2**	**4**	**6**	**8**
P1	**1**	**2**	**3**	**4**
	D1	**D2**	**D3**	**D4**

R > 8	**Azione correttiva immediata**
4 ≤ R ≥ 8	**Azione correttiva urgente**
2 ≤ R ≥ 3	**Azione correttiva eseguibile**
R = 1	**Azione correttiva non necessaria**

Valore	Livello	Definizione
4	Pericolo elevato	Totale perdita del biomarcatore nutrizionale. Totale perdita della qualità nutrizionale.
3	Pericolo moderato	Perdita importante del biomarcatore nutrizionale. Parziale perdite della qualità nutrizionale
2	Pericolo lieve	Parziale perdita del biomarcatore nutrizionale. Lieve perdita della qualità nutrizionale
1	Sicurezza	Ridotta perdita del biomarcatore nutrizionale. Lievissima perdita della qualità nutrizionale

Dalla Valutazione dell’Impatto Ambientale Alla Valutazione Impatto sulla Salute VIAS

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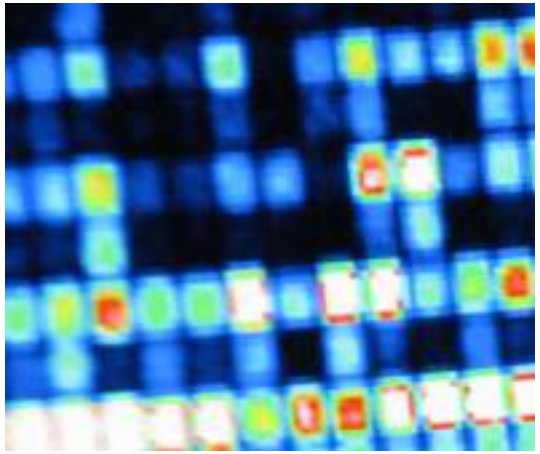
Livello 1
Analisi dello Stato Nutrizionale: abitudini alimentari, stile di vita e composizione Corporea

Effetto sul Consumatore

Scelta di un biomarker diagnostico

Livello 2
Analisi delle caratteristiche biochimiche: studio del profilo lipidico, glucidico, ossidativo ed infiammatorio



Livello 3
Analisi Nutrigenetiche e Nutrigenomiche

III. INTEGRAZIONE AMBIENTE- SALUTE- DETERMINANTI SOCIO-CULTURALI.

CONCETTI GUIDA:
Si considera che:
1) le Problematiche Nutrizionali identificate, non possono essere efficacemente contrastate con l'esclusivo intervento sanitario ma necessitino di un approccio intersettoriale integrato;
2) sia necessario attivare programmi di prevenzione di sovrappeso e obesità;
3) sia opportuno promuovere l'implementazione dei LARN in particolare nella sorveglianza nutrizionale e nella ristorazione collettiva;
4) sia necessario promuovere l'ecologia nutrizionale;
5) sia indispensabile proteggere i cittadini/consumatori dalle errate comunicazioni e informazioni.

d. Promuovere e incoraggiare l'adozione del processo NACCP nelle strutture di prevenzione territoriali (SIAN e VET) per favorire politiche sicurezza alimentare e nutrizionale, l'ottimizzazione delle capacità di controllo, un univoco progresso integrato e una comunicazione efficace (Vedi Allegato III – 3)

Allegato III- 3
L'implementazione efficace dei LARN in particolare nella sorveglianza nutrizionale e nella ristorazione collettiva può essere favorito dalle seguenti azioni:

- monitoraggio a livello delle singole Regioni per verificare come procede il recepimento della nuova revisione LARN che recepisce i valori di riferimento per la dieta (DRVs) applicandoli per la popolazione italiana;
- prevedere, sui capitolati di appalto destinati alle ristorazioni collettive, l'utilizzo di tabelle dietetiche redatte secondo i LARN e le Linee Guida per una Sana Alimentazione approvate dai SIAN e il riferimento ai criteri ambientali minimi (CAM) e ai criteri sociali minimi (CSM) definiti dal Ministero dell'Ambiente per i green public procurement (GPP) e i social public procurement (SPP) [(1)] (integrando: salvaguardia della salute/contesto socio-culturale/sostenibilità ambientale);
- attivare le necessarie collaborazioni con il ministero dell'agricoltura e dell'ambiente per l'avvio dell'aggiornamento della Banca dati italiana di Composizione degli alimenti;
- Promuovere l'adozione del processo NACCP nelle strutture di prevenzione territoriali per favorire il coordinamento di politiche di qualità in ambito alimentare e nutrizionale
- prevedere l'adozione di strumenti informatici di automonitoraggio per l'aderenza alla dieta mediterranea (calcolo dell'indice di adeguatezza alla dieta mediterranea).