GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Jornada ANICE – PROCARSE

"Oportunidades y Desarrollo de Carne y Productos Cárnicos Saludables y Funcionales"

20 Septiembre 2016

Posibilidades y estrategias para mejorar aspectos cuantitativos y cualitativos del material lipídico.

Índice

- ¿Por qué mejorar el perfil lipídico?
- Estrategias para mejorar la fracción lipídica de la materia prima
- Estrategias para mejorar la fracción lipídica del producto procesado

ALIMENTACIÓN SALUDABLE

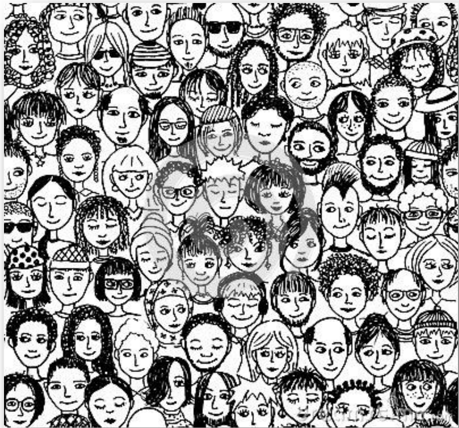
Cantidad suficiente de todos los <u>nutrientes</u> necesarios para el normal funcionamiento del organismo

ALIMENTACIÓN ÓPTIMA

Cantidad suficiente de todos los nutrientes necesarios para el normal funcionamiento del organismo

Reducir riesgo de enfermedades

Compuestos beneficiosos para la salud



Hábitos alimenticios tradicionales buscando el equilibrio

Hábitos alimenticios más sofisticados introduciendo alimentos con valor añadido

- ✓ Dieta no adecuada
- ✓ Sedentarismo

Enfermedades responsables de los mayores índices de morbi/mortalidad en países desarrollados y en vías de desarrollo:

- Obesidad
- Enfermedades cardiovasculares
- Diabetes tipo 2
- Hipertensión
- Osteoporosis
- Cáncer (ciertos tipos)

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ALIMENTACIÓN ÓPTIMA

¿Lípidos?

Lípidos

Lípidos: moléculas orgánicas insolubles en agua

TIPOS DE LÍPIDOS

- **SAPONIFICABLES**
  - Acilglicéridos (TG)
  - Ceras
  - Fosfoglicéridos
  - Esfingolípidos
  - Cerebrósidos
  - Gangliósidos
- **INSAPONIFICABLES**
  - Terpenos:
    - Escualeno
    - Carotenos
    - Tocoferoles
  - Esteroles:
    - Fitoesteroles
    - Colesterol

Lípidos

Función como Nutrientes
Equilibrio: cantidad/calidad

Lípidos: moléculas orgánicas insolubles en agua

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FUNCIONES EN EL ORGANISMO

Triglicéridos

1. Aporte energético 1g - 9 kcal
2. Función estructural y aislante térmico
3. Precursores de otros lípidos (fosfolípidos y colesterol)

Fosfolípidos

1. Función estructural

Ácidos grasos esenciales

1. Precursores de:
   - Prostaglandinas
   - Leucotrienos
   - Tromboxanos

Colesterol

1. Función estructural
2. Precursor de ácidos biliares y hormonas esteroideas

Lipoproteínas: transporte de lípidos

RECOMENDACIONES DE INGESTA DE LÍPIDOS

efsa
European Food Safety Authority

Table 5: Overview of dietary recommendations for the intakes of total fat and fatty acids intakes for adults as set by different organisations.

Countries / Organisation	Year	Total fat	SFA	TFA	*cis*-MUFA	PUFA	Cholesterol
United Kingdom	1991	33 E%	<10 E%	< 2 E%	12 E%	6 E% with at least 1 E% LA and 0.2 E% ALA	
Germany, Austria, Switzerland	2000	30 E%	<10 E%	< 1 E%		Total PUFA: 7-10 E%, n-6 PUFA 2.5 E%, n-3 PUFA: 0.5 E%	< 300 mg per day
France	2001 2005	30-35 E%	<8 E%	< 2 E%	20 E%	4 E% of which 4 % LA, 0.8 E% ALA, 0.20 E% LCPUFA, and 0.05 E% DHA	
The Netherlands	2001 2006	20-40 E%	< 10 E%	alap		<12 E% of which at least 2 E% LA, 1.0 E% ALA, 450 mg EPA + DHA	
USA	2002 2005	20-35 E%	< 10 E%	alap		5-10 E% LA, 0.6-1.2 E% ALA	
WHO/FAO	2003	15-30 E%	< 10 E%	< 1 E%		6-10 E%, of which 5-8 E% n-6 PUFA and 1-2 E% n-3 PUFA	< 300 mg per day
Nordic Countries	2004	25-35 E%	<10 E% (includes TFA)		10-15 E%	5-10%, of which 1 E% n-3 fatty acids	

SFA: Saturated fatty acids; TFA: *Trans* fatty acids; *cis*-MUFA: *cis*-monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids; LA: Linoleic acid; ALA: alpha-linolenic acid; EPA: eicosapentaenoic acid; DHA: docosahexaenoic acid; alap = as low as possible; E%: percent of energy.

Fuente: EFSA Journal (2010)

DOI: 10.2903/j.efsa.2010.1461

RECOMENDACIONES DE INGESTA DE LÍPIDOS

GRASA TOTAL	AGS	AGTrans	AGP	Colesterol - AGM
20-35 % DE LA ENERGÍA TOTAL	ALAP	ALAP	-	-
			AI=4% ET (linoléico) AI=0,5% ET (linolénico) AI=250mg/d EPA+DHA (>1g/d beneficio CV)	

Fuente: EFSA Journal (2010)

DOI: 10.2903/j.efsa.2010.1461

RECOMENDACIONES DE INGESTA DE LÍPIDOS

Nutrición Hospitalaria

Nutr Hosp. 2015;32(2):435-47
ISSN 0212-1611 • CODEN NUHOE
S.V.R. 31

Artículo especial

Consenso sobre las grasas y aceites en la alimentación de la población española adulta; postura de la Federación Española de Sociedades de Alimentación, Nutrición y Dietética (FESNAD)

Emilio Ros[1,2], José López-Miranda[2,3], Catalina Picó[2,4], Miguel Ángel Rubio[5], Nancy Babio[2,6], Aleix Sala-Vila[1,2], Francisco Pérez-Jiménez[2,3], Eduard Escrich[7], Mònica Bulló[2,6], Montserrat Solanas[7], Angel Gil Hernández[8] y Jordi Salas-Salvadó en nombre de la FESNAD[2,6]

AGS: Reducción consumo algunas carnes procesadas (entre otros alimentos)

AGT: <1% ET

AGM: Sustituir AGS o HC por AGM (mejora factores de riesgo CV, control glucémico y perfil lipídico)

AGP n-6: Ingesta deseable de 5-10% ET (10-20g/d)

AGP n-3: EPA y DHA: ingesta deseable de 0,1-1% ET (0,25-2,5g/d)
ALA: ingesta deseable de 0,5-1% ET

Grasa total: 'Mientras la mayor parte de la grasa dietética sea insaturada, se considera innecesario establecer un dintel superior de ingesta de grasa total en la población española'

Evidencia científica

Grasa Total // Cáncer

U.S. Food and Drug Administration
Protecting and Promoting *Your* Health

Approved Claims	Requirements for the Food	Claim Requirements	Model Claim, Statements
Dietary Fat and Cancer **(21 CFR 101.73)**	Low fat (Fish & game meats: "Extra lean")	Required terms: "Total fat" or "Fat" "Some types of cancers" or "Some cancers" Does not specify types of fats or fatty acids that may be realted to risk of cancer.	**Development of cancer depends on many factors. A diet low in total fat may reduce the risk of some cancers.**

"Based on the totality of the publicly available scientific evidence, there is significant scientific agreement among experts, qualified by training and experience to evaluate such evidence, that **diets high in total fat are associated with an increased cancer risk**. Research to date, although not conclusive, demonstrates that **the total amount of fats, rather than any specific type of fat, is positively associated with cancer risk**. The mechanism by which total fat affects cancer has not yet been established."

AGS // niveles de colesterol sérico

THE INFLUENCE OF DIETARY FATS ON SERUM-LIPID LEVELS IN MAN

EDWARD H. AHRENS, JUN. M.D.
JULES HIRSCH M.D.
WILLIAM INSULL, JUN. M.D.
THEODORE T. TSALTAS * M.D.
ROLF BLOMSTRAND † M.D.
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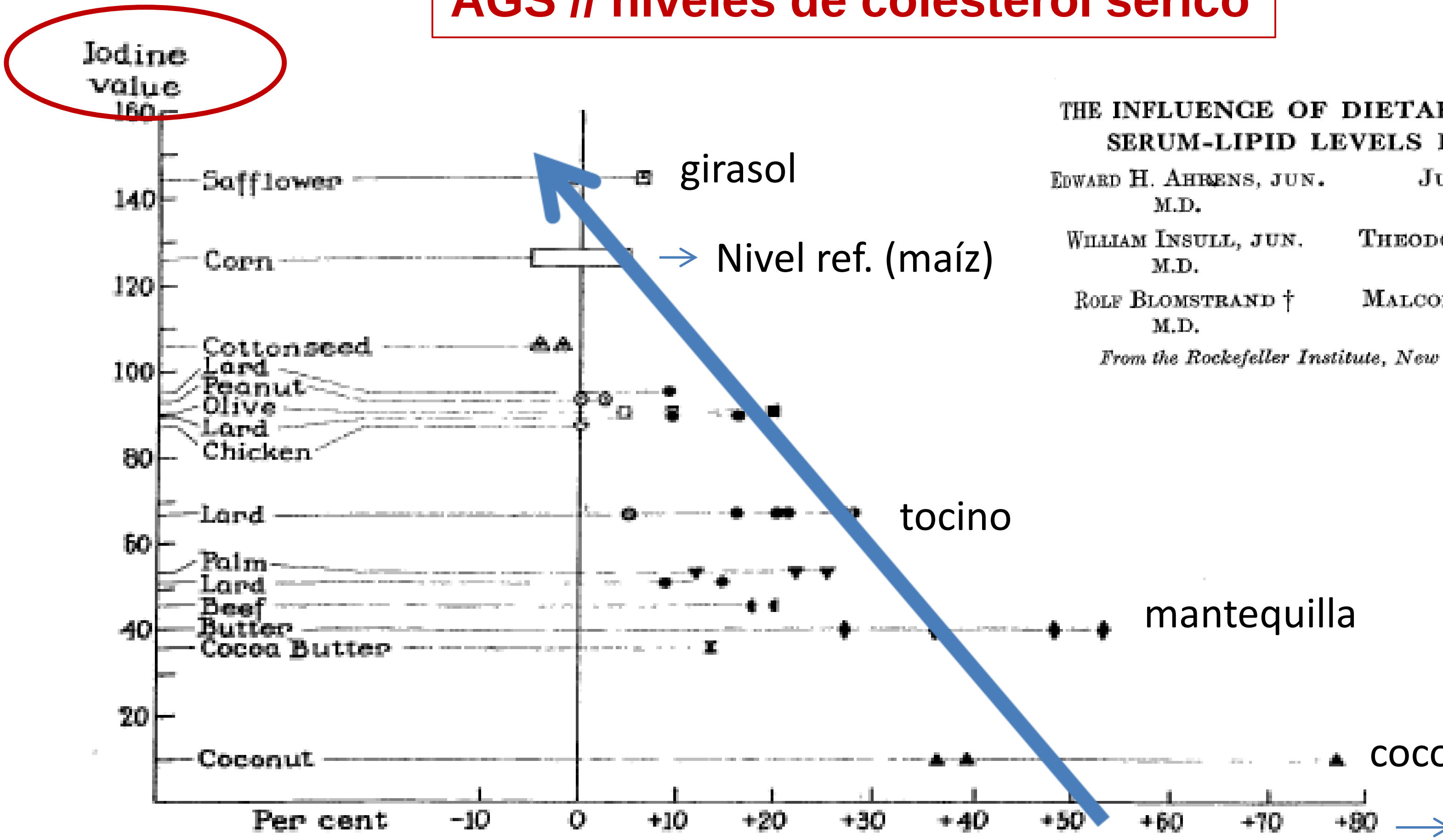
From the Rockefeller Institute, New York, N.Y.



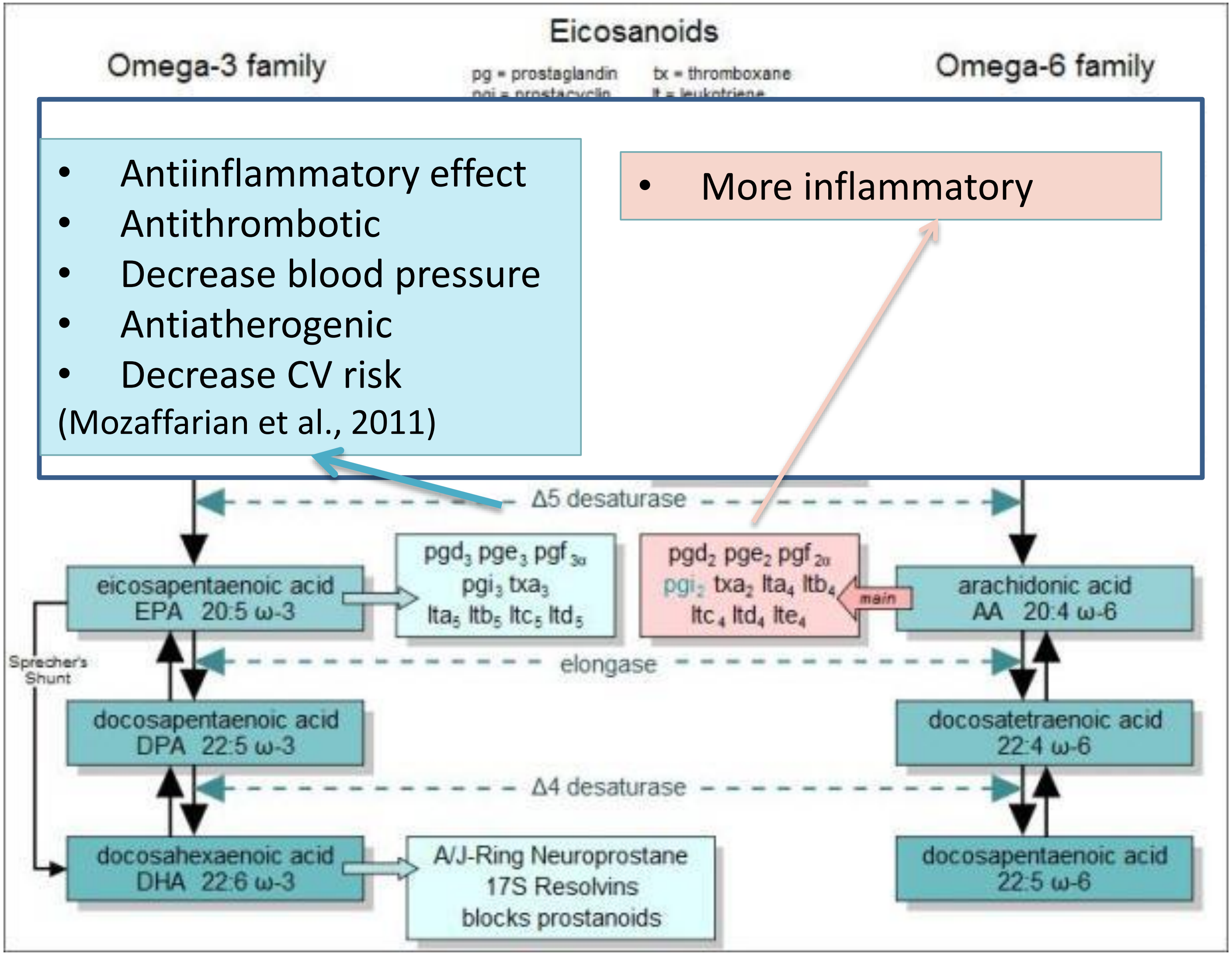
Niveles de colesterol sérico referido al nivel basal ingiriendo aceite de maíz

Fig. 7—Relationship between iodine values of dietary fats and serum-cholesterol levels, expressed as percentage differences from base-lines established during ingestion of corn oil.

Iodine values of fats listed along vertical axis. Open bar at I. V. 126 = estimated reproducibility of corn-oil base-line (fig. 2). Open symbols represent results not significantly different from base-line, solid symbols different at level of $P < 0.01$, hatched symbols different at level of $P < 0.05$.

Elevan el colesterol total, especialmente el LDL-colesterol

AGP



- Antiinflammatory effect
- Antithrombotic
- Decrease blood pressure
- Antiatherogenic
- Decrease CV risk

(Mozaffarian et al., 2011)

- More inflammatory

"A lower ratio of omega-6/omega-3 fatty acids is more desirable in reducing the risk of many of the chronic diseases of high prevalence in Western societies"

Simopoulos, 2002

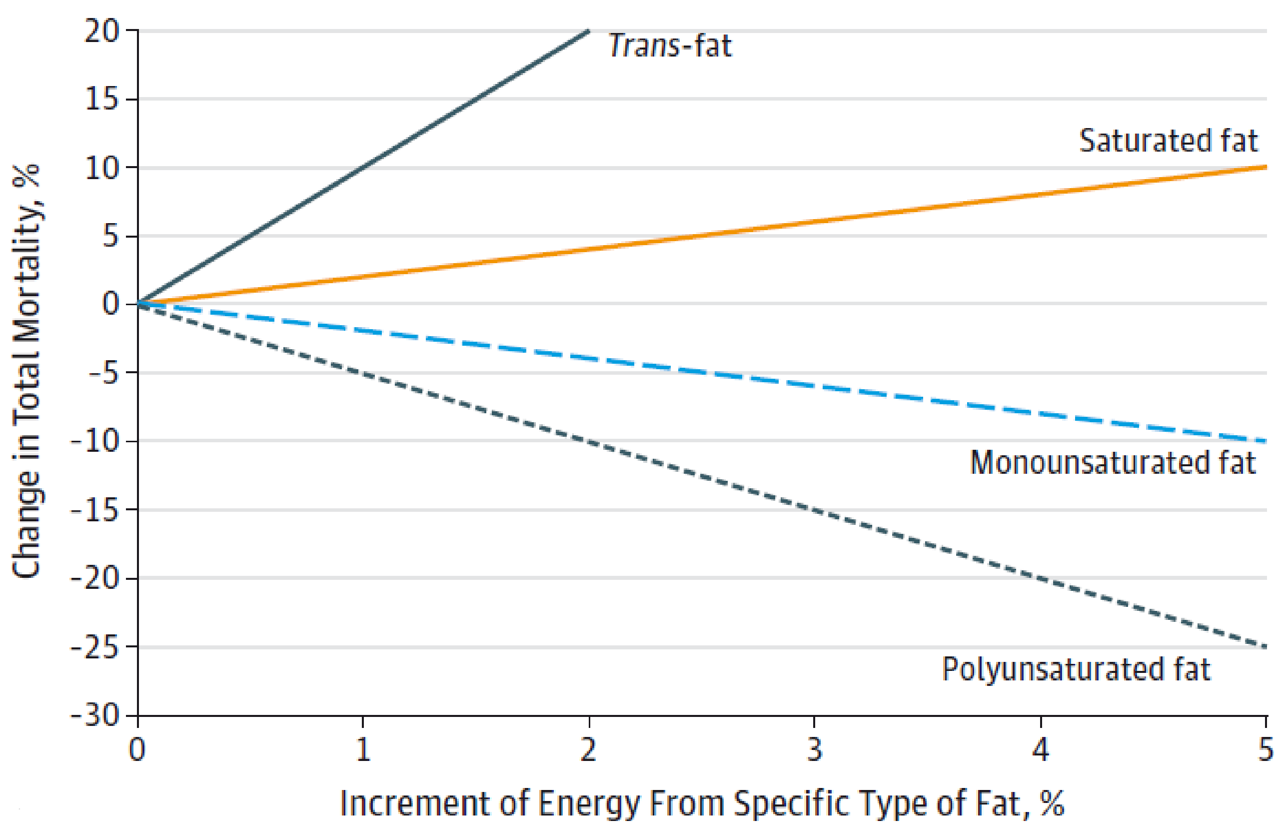
Valor actual: 17/1
Objetivo: <4/1

JAMA Internal Medicine | Original Investigation

Association of Specific Dietary Fats With Total and Cause-Specific Mortality

Dong D. Wang, MD, MSc; Yanping Li, PhD; Stephanie E. Chiuve, ScD; Meir J. Stampfer, MD, DrPH; JoAnn E. Manson, MD, DrPH; Eric B. Rimm, ScD; Walter C. Willett, MD, DrPH; Frank B. Hu, MD, PhD

Figure 1. Change in Total Mortality Associated With Increases in the Percentage of Energy From Specific Types of Fat



AMA Intern Med. 2016;176(8):1134-1145.

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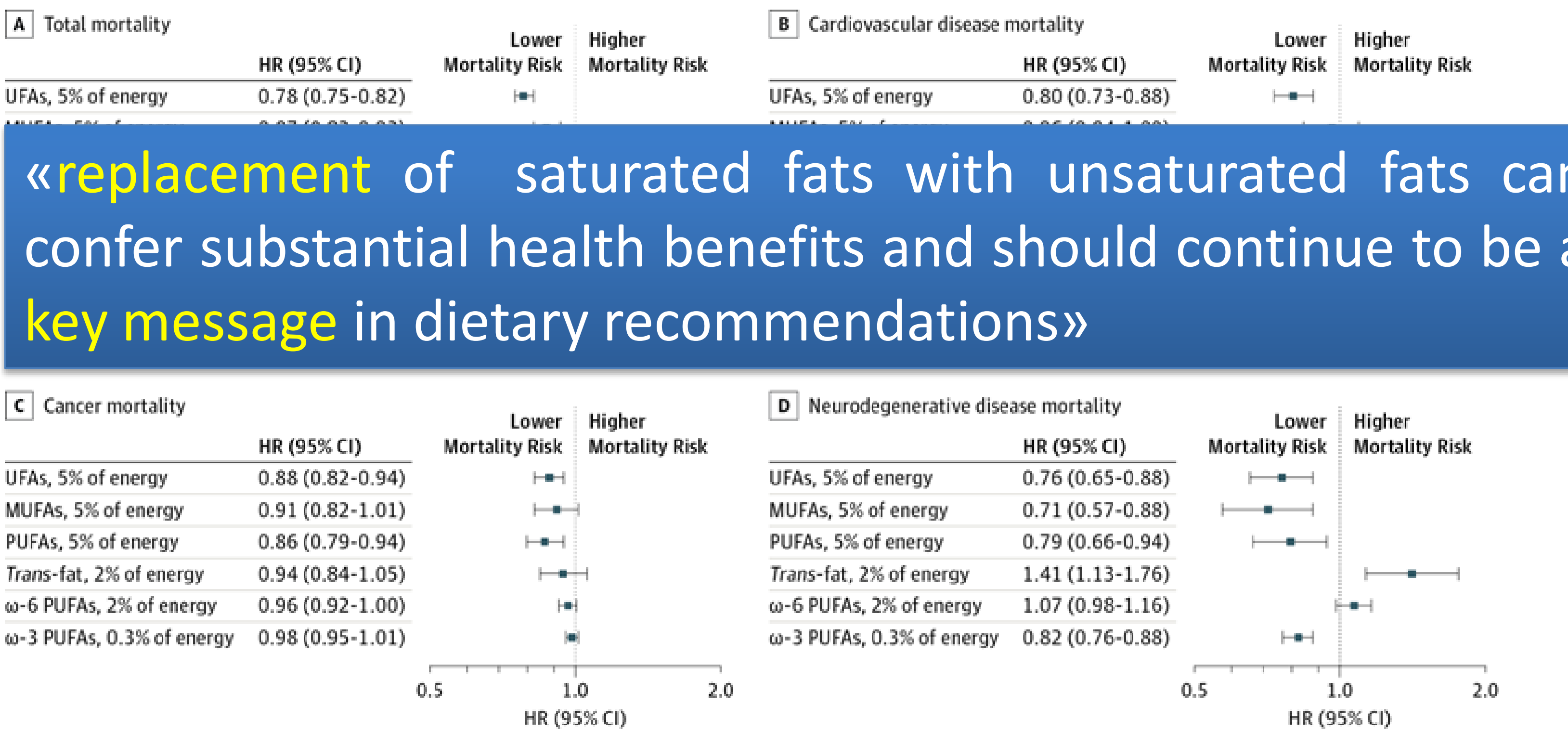
Sustitución isocalórica de grasa saturada por otras grasas



A Total mortality

	HR (95% CI)
UFAs, 5% of energy	0.78 (0.75-0.82)

B Cardiovascular disease mortality

	HR (95% CI)
UFAs, 5% of energy	0.80 (0.73-0.88)

«replacement of saturated fats with unsaturated fats can confer substantial health benefits and should continue to be a key message in dietary recommendations»

C Cancer mortality

	HR (95% CI)
UFAs, 5% of energy	0.88 (0.82-0.94)
MUFAs, 5% of energy	0.91 (0.82-1.01)
PUFAs, 5% of energy	0.86 (0.79-0.94)
Trans-fat, 2% of energy	0.94 (0.84-1.05)
ω-6 PUFAs, 2% of energy	0.96 (0.92-1.00)
ω-3 PUFAs, 0.3% of energy	0.98 (0.95-1.01)

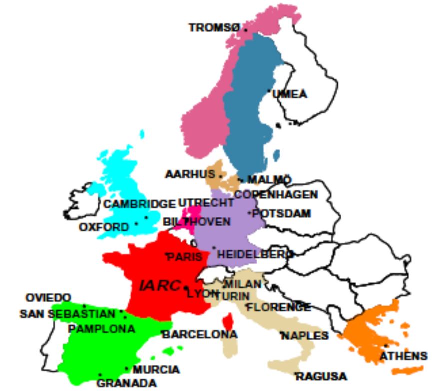
D Neurodegenerative disease mortality

	HR (95% CI)
UFAs, 5% of energy	0.76 (0.65-0.88)
MUFAs, 5% of energy	0.71 (0.57-0.88)
PUFAs, 5% of energy	0.79 (0.66-0.94)
Trans-fat, 2% of energy	1.41 (1.13-1.76)
ω-6 PUFAs, 2% of energy	1.07 (0.98-1.16)
ω-3 PUFAs, 0.3% of energy	0.82 (0.76-0.88)

AMA Intern Med. 2016;176(8):1134-1145.

Grasa y Cáncer

Diet and cancer prevention: Contributions from the European Prospective Investigation into Cancer and Nutrition (EPIC) study
Gonzalez & Riboli (2010). European J. Cancer 46, 2555-2562



Conclusion: "An increased risk of breast cancer was associated with high saturated fat intake and alcohol intake"

Asociación:
Alta ingesta AGS // Incremento Riesgo Cáncer de mama

Association of dietary fat intakes with risk of esophageal and gastric cancer in the NIH-AARP diet and health study.
O'Doherty et al. (2012). Int. J. Cancer 131, 1376–1387

Conclusion: "Overall, we found null associations between the dietary fat intakes with esophageal or gastric cancer risk; although a protective effect of polyunsaturated fat intake was seen for EAC in subjects with a normal BMI."

No asociación
Grasa // riesgo cáncer gástrico o esofágico

Cierto efecto protector de AGP en el caso de adenocarcinoma esofágico

LÍPIDOS Y SALUD

¿ Y que pasa con los LÍPIDOS/CARNE?

COMPOSICION Y VALOR NUTRITIVO DE LA CARNE

PROTEÍNA
16-22%
Alto VB

VITAMINAS
B1,B2,B3,B6,B12

MINERALES
Fe hemo y Zn muy biodisponibles
P, K, Na

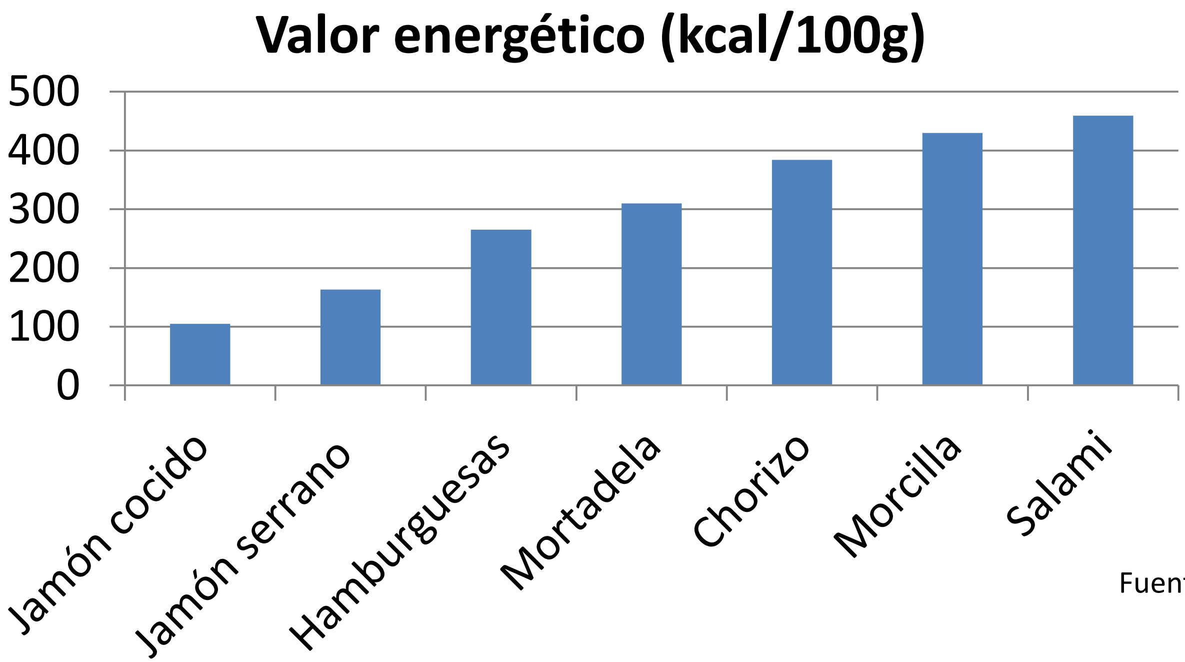
Agua
60-80%

HC
Trazas

GRASA
2-13%
Alta proporción de AGS (cerdo AGM)
Colesterol 60-80 mg/100g

Valor energético: 130-300kcal/100g

DERIVADOS CÁRNICOS



Valor nutritivo muy variable

Fuente: Bedca (2016) y Moreiras (2013)

Derivados cárnicos: embutidos, salazones, adobados, productos cocidos, patés, extractos de carne

- Porcentaje de grasa (3-40%)
- AGS: > 35%
- Proporción de sal
- Presencia de nitritos

ALIMENTACIÓN ÓPTIMA

NO saludables

Compuestos bioactivos

Saludables

Productos cárnicos funcionales

Alimentación animal: modificación materia prima

Reformulación: ingredientes y tecnologías

NO saludables

Compuestos bioactivos

Saludables

GRASA

- **Textura, jugosidad, palatabilidad, consistencia, estabilidad……**

Estrategias para mejorar la fracción lipídica de la materia prima

- Incremento masa magra
- Reducción de grasa intramuscular
- Mejora perfil lipídico
- Incremento estabilidad lipídica y depósito de vitamina E.

✓ Lauridsen et al. (1999)
✓ Enser et al. (2000)
✓ D´Arrigo et al. (2002)
✓ **Hoz et al. (2004)**
✓ **Toldrá et al. (2004)**
✓ Pascual et al. (2005)
✓ Noci et al. (2005)
✓ Elmore et al. (2005)
✓ **Rubio et al. (2007)**
✓ **Ventanas et al. (2007, 2008)**
✓ Soto et al. (2009)
✓ **Bañón et al. (2010)**
✓ Vossen et al. (2012)
✓ Xiao et al. (2012)
✓ **Zurita-Herrera et al. (2013)**
✓ **Hernández-López et al. (2016)**
✓ **De Jesús et al. (2016)**

Estrategias para mejorar la fracción lipídica de la materia prima

Hoz et al., 2003

L aceite de lino
LE aceite de lino + vit E
LO aceite de lino + oliva
LOE aceite de lino + oliva + vitE

Table 2
Effect of dietary treatment on fatty acid composition (% of total fatty acids) of tenderloin (*Psoas major*) muscle[a]

Fatty acid[b]	Diets[c]					Pooled S.D.[d]
	C	L	LE	LO	LOE	
Total SFA[b]	34.62	36.22	37.44	36.47	35.81	1.951
Total MUFA	38.30	37.19	37.52	40.51	40.73	3.081
Total PUFA	26.91	26.44	24.92	22.90	23.24	3.798
n-6 dienoic	22.70a	16.22b	14.50b	14.85b	15.25b	3.309
n-6 PUFA	1.22	1.04	0.67	0.76	1.96	0.307
n-3 dienoic	0.03	0.05	0.06	0.05	0.04	0.015
n-3 PUFA	2.10b	8.55a	9.18a	6.73a	6.42a	1.769
Total n-3	2.13b	8.60a	9.24a	6.78a	6.46a	1.777
Total n-6	23.92a	17.25b	15.17b	15.61b	16.21b	2.293
n-6/ n-3	11.23a	2.01b	1.64c	2.30b	2.51b	0.924

[c] Means diets containing C, control (sunflower oil, 30 g kg^{-1}); L, linseed oil (30 g kg^{-1}); LE, linseed oil (30 g kg^{-1}) + α-tocopheryl acetate (200 mg kg^{-1}); LO, linseed oil (15 g kg^{-1}) + olive oil (15 g kg^{-1}); LOE, linseed oil (15 g kg^{-1}) + olive oil (15 g kg^{-1}) + α-tocopheryl acetate (200 mg kg^{-1}).

Estrategias para mejorar la fracción lipídica de la materia prima

Avocado waste for finishing pigs: Impact on muscle composition and oxidative stability during chilled storage.

Hernández-López et al., Meat Science 116 (2016) 186–192.

- Dietary avocado (30% dm) had significant impact on the content and composition of intramuscular fat (IMF).
- Stability OK

Table 1
Analysis of CONTROL and TREATED experimental diets.

	CONTROL		TREATED	
	Mean	SD	Mean	SD
Moisture (g/100 g feed)	12.64	0.36	30.54	1.44
Crude Protein (g/100 g feed)	13.40	1.64	12.24	1.74
Ether extract (g/100 g feed)	0.31	0.09	3.22	0.13
Ash (g/100 g feed)	3.91	0.10	3.84	0.16
Tocopherol (mg/kg feed)	164.62	18.77	273.03	16.24
Digestibility (% dry matter)	87.33	1.81	86.25	1.85
Gross energy (kJ/g feed dry matter)	17.84	–	25.58	–

SD: standard deviation.

Table 2
Chemical composition and fatty acid profile of muscle *M. longissimus thoracis et lumborum* of pigs fed a control diet (CONTROL) and pigs fed an experimental avocado diet (TREATED).

	CONTROL		TREATED		
	Mean	SD	Mean	SD	p[a]
Moisture (g/100 g fresh loin)	71.16	1.40	73.92	1.45	<**0.001**
Protein (g/100 g fresh loin)	24.55	1.58	25.80	0.92	**0.043**
IMF (g/100 g fresh loin)	4.08	1.02	2.07	0.66	**0.004**
Ash (g/100 g fresh loin)	0.99	0.05	1.19	0.03	0.150
γ-Tocopherol (μg/g fresh loin)	3.34	0.39	3.11	0.42	0.464
α-Tocopherol (μg/g fresh loin)	3.70	0.83	5.62	0.92	**0.021**
Fatty acids (% of total fatty acids)					
C12	0.10	0.02	0.07	0.01	**0.019**
C14	1.83	0.27	1.36	0.13	**0.010**
C16	29.32	0.91	26.48	0.84	**0.002**
C17	0.24	0.06	0.19	0.03	0.102
C18	9.83	1.01	9.74	0.75	0.885
C20	0.13	0.03	0.10	0.01	0.072
Σ SFA	41.45	1.15	37.94	0.75	<**0.001**
C16:1 (n−7)	5.20	0.46	5.09	0.76	0.806
C17:1 (n−7)	0.28	0.18	0.24	0.03	0.683
C18:1 (n−9)	46.33	0.98	46.48	1.48	0.864
C20:1 (n−9)	0.70	0.11	0.55	0.07	**0.040**
Σ MUFA	52.50	1.36	52.36	1.61	0.894
C18:2 (n−6)	4.67	0.97	7.61	0.71	**0.001**
C18:3 (n−6)	0.06	0.01	0.07	0.02	0.346
C18:3 (n−3)	0.17	0.05	0.29	0.08	**0.029**
C20:2 (n−6)	0.13	0.03	0.18	0.05	0.105
C20:4 (n−6)	0.78	0.21	1.11	0.53	0.289
C20:3 (n−3)	0.04	0.02	0.04	0.01	0.658
C20:5 (n−3)	0.09	0.01	0.13	0.04	0.122
C22:2 (n−6)	0.14	0.02	0.19	0.03	**0.050**
C22:6 (n−3)	0.06	0.02	0.15	0.03	**0.002**
Σ PUFA	6.14	1.00	9.78	1.04	**0.001**
Σ LC-PUFA	1.24	0.16	1.88	0.27	**0.004**
SFA/UFA	0.71	0.03	0.61	0.02	<**0.001**
n−6/n−3	17.15	2.45	12.26	1.53	0.066

IMF: intramuscular fat; SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; LC-PUFA: long-chain PUFA.
[a] Significance level in student "T"-test. Bold p-values denote significant differences ($p \leq 0.05$).

Effect of the amount of chestnuts in the diet of Celta pigs on the fatty acid profile of dry-cured lacon.

De Jesús et al., Grasas y Aceites 67, e119 (2016).

Los lacones de animales alimentados por castaña (15 o 25% en el pienso) presentaron valores más altos de PUFA totales, PUFA n6 y PUFA n3.

Fatty acid	Diet			SEM	*Sig.*
	C	CH15	CH25		
C10:0	0.15±0.04	0.18±0.08	0.14±0.06	0.01	n.s.
C12:0	0.18±0.21	0.06±0.07	0.07±0.06	0.07	n.s.
C14:0	1.62±0.75	1.73±0.39	1.53±0.21	0.10	n.s.
C14:1	0.05±0.02	0.05±0.02	0.05±0.01	0.01	n.s.
C15:0	0.06±0.02[a]	0.12±0.05[a]	0.34±0.16[b]	0.03	***
C16:0	24.07±2.13[b]	20.43±1.82[a]	20.60±2.12[a]	0.54	**
C16:1n7	4.24±0.43[b]	2.75±0.39[a]	2.86±0.51[a]	0.17	***
C17:0	0.20±0.03	0.24±0.06	0.20±0.02	0.01	n.s.
C17:1n7	0.23±0.02[a]	0.38±0.03[c]	0.33±0.02[b]	0.01	***
C18:0	9.35±0.74[b]	7.46±0.50[a]	7.95±2.19[a]	0.31	*
C18:1n9	43.77±1.19	42.08±2.88	41.33±2.96	0.54	n.s.
C18:2n6	14.40±1.42[a]	19.31±1.11[b]	18.29±1.06[b]	0.52	***
C20:0	0.66±0.23[a]	0.86±0.06[b]	0.95±0.17[b]	0.04	**
C20:1n9	0.49±0.10	0.47±0.12	0.50±0.10	0.02	n.s.
C18:3n3	0.81±0.18[a]	1.53±0.13[c]	1.12±0.19[b]	0.07	***
C20:2n6	0.23±0.04[c]	0.14±0.01[b]	0.06±0.02[a]	0.01	***
C20:3n3	0.16±0.05[a]	0.33±0.16[b]	0.32±0.07[b]	0.03	*
C20:4n6	0.63±0.13	0.74±0.25	0.61±0.19	0.04	n.s.
C20:5n3	0.35±0.03[a]	1.42±0.43[b]	2.81±0.99[c]	0.24	***
C22:0	0.12±0.03	0.18±0.01	0.18±0.09	0.01	n.s.
C22:4n3	0.17±0.15	0.17±0.07	0.19±0.09	0.02	n.s.
C22:5n3	0.11±0.03[a]	0.25±0.07[b]	0.32±0.19[b]	0.03	*
C22:6n3	0.14±0.07[a]	0.29±0.10[b]	0.35±0.10[b]	0.03	**
C24:1n9	0.10±0.03	0.17±0.06	0.14±0.04	0.01	n.s.
SFA	36.60±1.69[b]	31.14±2.99[a]	30.55±2.31[a]	0.77	***
MUFA	48.85±1.51[b]	45.58±2.44[a]	45.21±2.92[a]	0.58	*
PUFA	16.84±1.51[a]	24.24±1.57[b]	24.44±2.32[b]	0.84	***
PUFA/SFA	0.46±0.04[a]	0.76±0.08[b]	0.80±0.10[b]	0.04	***
Σn3	1.05±0.21[a]	2.11±0.32[c]	1.79±0.30[b]	0.11	***
Σn6	15.22±1.52[a]	20.39±1.24[b]	19.28±1.10[b]	0.55	***
n6/n3	13.25±1.40[b]	9.89±1.26[a]	10.43±0.99[a]	0.40	***

C: concentrate feed (control); CH15: concentrate feed containing 15% dried chestnuts; CH25: concentrate feed containing 25% dried chestnuts; SEM=standard error of the mean; [a–b]Means in the same row with different letters differ significantly (*P*<0.05; Duncan test); Significance: *** (*P*<0.001), **(*P*<0.01), * (*P*<0.05), n.s (not significant)

Reformulación de productos procesados

European Commission

"High Level Group on Nutrition and Physical activity"

REFORMULATION

Reformulación de productos procesados

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  - Sustitución de la grasa por componentes menos energéticos: agua, hidratos de carbono (fibra).

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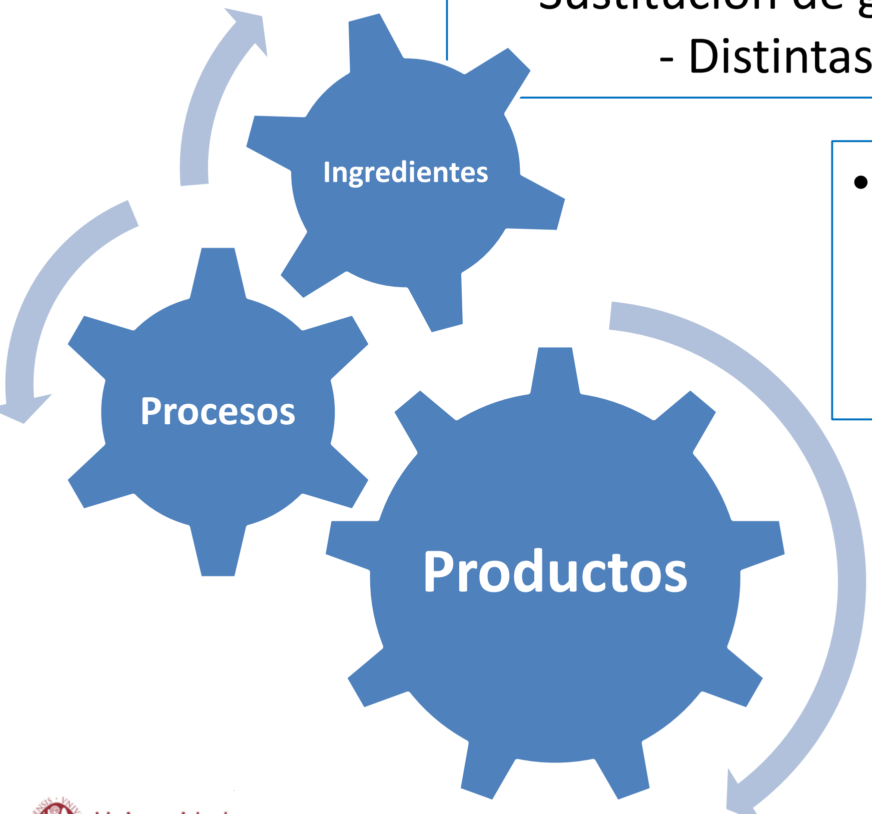
  - AGP omega-3 de apm (EPA, DHA)
  - Esteroles vegetales.



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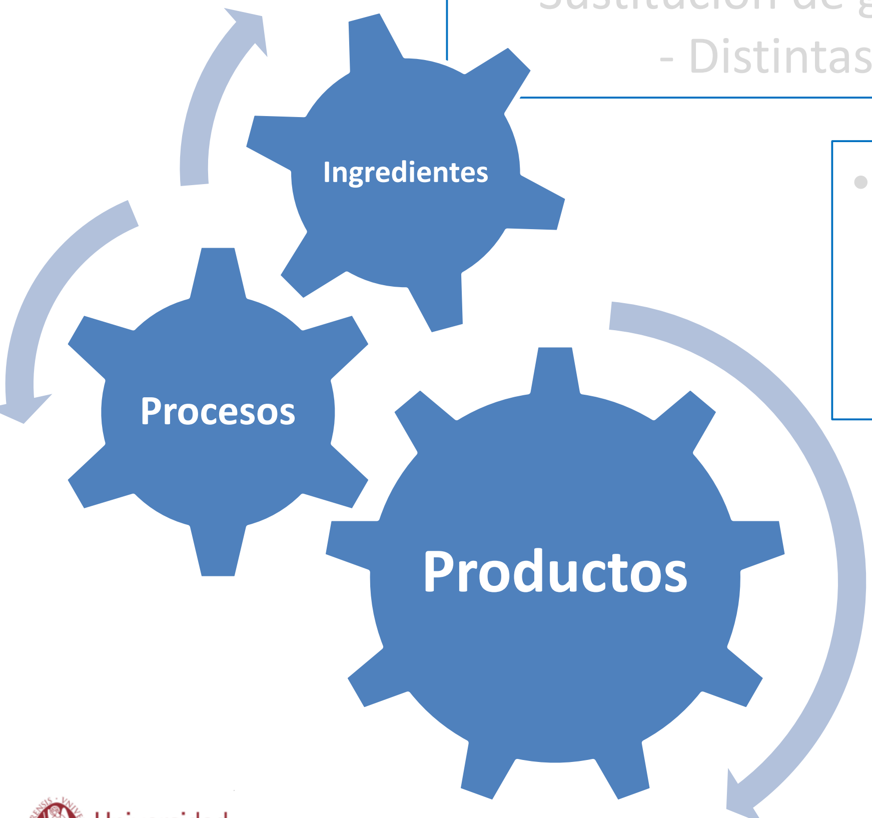

Table 3. Results for % fat reduction, calorific value and acceptability in relation to the use of inulin, cereals and fruit fibres as texture modifiers in low fat dry fermented sausages

		% Fat reduction	Calorific value (kcal/100 g)	Acceptability
Experiment with inulin[a]	Control high fat		392.2	7a
	Control low fat	48.5	305.7	5.9b
	R1 (7% inulin)	65.3	257.1	5.5b
	R2 (6%inulin)	55.9	271.0	5.4b
	R3 (11.5% inulin)	64.6	242.9	6.1b
	R4 (10% inulin)	60.1	251.5	5.4b
Experiment with dietary fibres[b]	Control 25% fat		435.9	6.48
	Control 6% fat	60	275.2	5.71cd
	Wheat 3%	65	281.9	4.04d
	Wheat 1.5%	61	300.6	6.10c
	Oat 3%	66	270.8	4.42d
	Oat 1.5%	68	264.6	6.12c
	Peach 3%	63	277	4.88d
	Peach 1.5%	57	290	6.08c
	Apple 1.5%	59	289.5	5.39cd
	Orange 1.5%	62	287.7	5.94cd
	Control 10% fat	62	287.9	5.99c
	Wheat 1.5%	61	292.3	5.09c
	Oat 1.5%	63	289	5.57c
	Peach 1.5%	59	277.5	5.93c
	Apple 1.5%	61	269.9	6.00c
	Orange 1.5%	57	278.9	6.33c

[a] Experiment with inulin: Source Mendoza *et al.* (2001). Data with the same letters did not show significant differences between them at level of significance of $p<0.05$.
[b] Experiment with dietary fibres: Source García *et al.* (2002). Data with the same letters did not show significant differences between them at level of significance of $p<0.05$.

Table 1 Proximate composition of experimental batches at the end of ripening (%)

Bach	Water	Protein	Fat	Ash	Carbohydrates		Fat reduction (%)	Caloric value (kcal per 100 g)
					Sausage	Fibre		
Experiment 1								
Conventional control	28.76 ± 0.80	25.30 ± 1.13	38.06 ± 1.90	3.91 ± 1.04	2.97	0		456
2%	27.91 ± 1.70	24.53 ± 0.61	36.94 ± 1.42	3.79 ± 0.36	2.82	3.01		446
4%	27.61 ± 3.95	24.35 ± 1.31	35.42 ± 1.56	3.68 ± 0.68	2.11	5.83		434
6%	26.90 ± 1.60	23.74 ± 2.01	35.47 ± 1.34	3.56 ± 0.63	2.53	8.75		438
Experiment 2								
Control 15%	37.92 ± 0.46	31.72 ± 2.46	23.84 ± 2.13	2.88 ± 0.86	3.64	0	37	356
2%	37.81 ± 0.69	30.79 ± 0.86	23.14 ± 2.58	2.80 ± 0.79	2.54	2.92	37	346
4%	35.63 ± 0.37	29.86 ± 1.61	22.54 ± 1.33	2.71 ± 0.13	3.42	5.84	36	345
6%	34.74 ± 0.66	28.97 ± 1.61	21.89 ± 1.03	2.58 ± 0.46	3.18	8.66	38	339
Experiment 3								
Control 6%	43.23 ± 1.46	34.97 ± 2.26	15.88 ± 1.34	2.64 ± 0.75	3.15	0	58	296
2%	42.10 ± 1.65	33.45 ± 0.92	15.42 ± 1.62	2.56 ± 0.35	1.62	2.92	58	284
4%	40.85 ± 2.35	33.04 ± 1.64	15.06 ± 0.48	2.48 ± 0.34	2.95	5.78	57	288
6%	39.60 ± 1.59	31.63 ± 2.01	14.80 ± 1.10	2.41 ± 0.52	2.87	8.67	58	284

Utilización de FOS de cadena corta

Table 5 Effect of reduction and addition of sc-FOS on the sensory properties of dry fermentd sausages (mean ± standard deviation)†

Batch	Odour	Colour	Taste	Texture	Overall acceptability	Global quality
Experiment 1						
Conventional control	7.17 ± 1.89[a]	7.86 ± 1.31[a]	7.15 ± 1.45[a]	6.70 ± 1.11[b]	6.83 ± 1.31[a]	7.09 ± 1.41[a]
2%	6.95 ± 2.05[a]	7.71 ± 1.49[a]	6.98 ± 1.71[a]	6.69 ± 1.73[b]	6.68 ± 1.60[a]	6.95 ± 1.73[a]
4%	6.56 ± 1.63[a]	7.80 ± 1.27[a]	7.08 ± 1.57[a]	6.90 ± 1.22[b]	6.96 ± 1.23[a]	7.02 ± 1.44[a]
6%	6.83 ± 1.54[a]	8.03 ± 1.07[a]	7.12 ± 1.18[a]	7.45 ± 1.48[a]	7.56 ± 1.15[a]	7.24 ± 1.29[a]
Experiment 2						
Control 15%	7.47 ± 1.12[a]	8.20 ± 0.71[a]	7.45 ± 1.18[a]	7.16 ± 1.35[a]	7.55 ± 0.71[a]	7.45 ± 1.15[a]
2%	7.14 ± 1.30[a]	7.82 ± 0.88[a]	7.16 ± 1.18[a]	7.11 ± 1.27[a]	7.16 ± 1.02[a]	7.21 ± 1.17[a]
4%	7.27 ± 1.31[a]	7.43 ± 1.32[b]	7.42 ± 1.12[a]	6.93 ± 1.66[a]	6.88 ± 1.68[a]	7.27 ± 1.29[a]
6%	7.39 ± 1.45[a]	8.37 ± 0.71[a]	7.44 ± 1.29[a]	7.17 ± 1.03[a]	7.42 ± 1.11[a]	7.44 ± 1.17[a]
Experiment 3						
Control 6%	7.37 ± 1.33[a]	7.28 ± 1.69[a]	7.01 ± 1.69[a]	6.70 ± 2.14[a]	6.80 ± 1.88[a]	6.99 ± 1.72[a]
2%	6.82 ± 1.80[a]	7.88 ± 1.32[a]	6.63 ± 1.55[a]	7.09 ± 1.50[a]	6.66 ± 1.47[a]	6.88 ± 1.54[a]
4%	7.21 ± 1.45[a]	7.62 ± 1.39[a]	6.48 ± 1.83[a]	7.17 ± 1.59[a]	6.53 ± 1.77[a]	6.87 ± 1.65[a]
6%	7.30 ± 1.41[a]	7.26 ± 1.31[a]	6.84 ± 1.74[a]	6.76 ± 1.90[a]	6.28 ± 1.62[a]	6.92 ± 1.68[a]

Means followed by a different letter within the same column are significantly different ($P < 0.05$).
†Statistical analysis was performed independently for each experiment.

Fuente: Short-chain fructooligosaccharides as potential functional ingredient in dry fermented sausages with different fat levels . International Journal of Food Science and Technology 2009, 44, 1100–1107.

Grupo Dra. Selgas. UCM

Utilización de chia

Table 2
Proximate analysis (%), energy content (kcal/100 g of product) and mineral content (mg/100 g product) of frankfurters.

Parameters	Samples*					
	N/P	R/P	R/CP	R/CO	R/CE	R/CEGA
Proximate analysis						
Moisture	59.18^{a} ± 0.05	68.99^{d} ± 0.23	63.42^{b} ± 0.06	64.01^{c} ± 0.03	63.29^{b} ± 0.14	63.37^{b} ± 0.39
Protein	14.17^{a} ± 0.16	14.03^{a} ± 0.16	16.12^{b} ± 0.13	15.96^{b} ± 0.40	16.24^{b} ± 0.14	16.39^{b} ± 0.11
Fat	23.05^{b} ± 0.36	12.52^{a} ± 0.82	13.27^{a} ± 0.15	13.03^{a} ± 0.13	13.16^{a} ± 0.06	12.53^{a} ± 0.19
Total dietary fibre	-	-	4.90^{a} ± 0.57	5.80^{a} ± 0.65	5.00^{a} ± 0.56	5.71^{a} ± 0.66
Ash	2.80^{a} ± 0.03	2.66^{a} ± 0.04	3.06^{b} ± 0.05	3.03^{b} ± 0.01	3.21^{c} ± 0.11	3.62^{d} ± 0.06
Energy content	264.13	171.46	196.65	195.61	196.34	192.64
Mineral content						
Sodium	755.6^{b} ± 19.8	735.9^{b} ± 18.8	724.9^{b} ± 32.9	635.7^{a} ± 44.1	699.4^{ab} ± 30.7	774.0^{b} ± 52.0
Potassium	211.8^{a} ± 12.8	221.7^{a} ± 2.5	281.4^{c} ± 7.8	253.4^{b} ± 12.5	278.6^{c} ± 0.9	307.3^{c} ± 6.5
Magnesium	14.68^{a} ± 0.83	16.35^{a} ± 0.14	41.53^{b} ± 1.41	42.58^{b} ± 2.27	43.52^{b} ± 1.03	47.13^{c} ± 0.94
Calcium	5.40^{a} ± 0.34	7.39^{b} ± 0.87	55.75^{c} ± 2.41	58.83^{c} ± 4.85	60.13^{c} ± 1.99	116.04^{d} ± 4.23
Iron	0.79^{a} ± 0.09	0.93^{a} ± 0.21	1.26^{b} ± 0.07	1.31^{b} ± 0.09	1.38^{b} ± 0.27	1.32^{b} ± 0.05
Manganese	0.08^{a} ± 0.00	0.09^{a} ± 0.00	0.51^{b} ± 0.02	0.54^{b} ± 0.04	0.53^{b} ± 0.01	0.55^{b} ± 0.01
Phosphorus	219.3^{a} ± 3.1	226.6^{a} ± 0.9	297.6^{b} ± 1.4	288.9^{b} ± 10.53	298.0 ^{b} ± 6.9	359.1^{c} ± 9.9

*For samples denominations see Table 1.
Means ± standard deviation. Different letters in the same row indicate significant differences ($P < 0.05$).

chia | chia/OO | chia/OO (emulsificado) | chia/OO (alginato)

Pintado et al. Strategies for incorporation of chia (*Salvia hispanica* L.) in frankfurters as a health-promoting ingredient. Meat Sci 2016, 114, 75-84.

Reformulación de productos procesados

- Reducción de grasa (energía)
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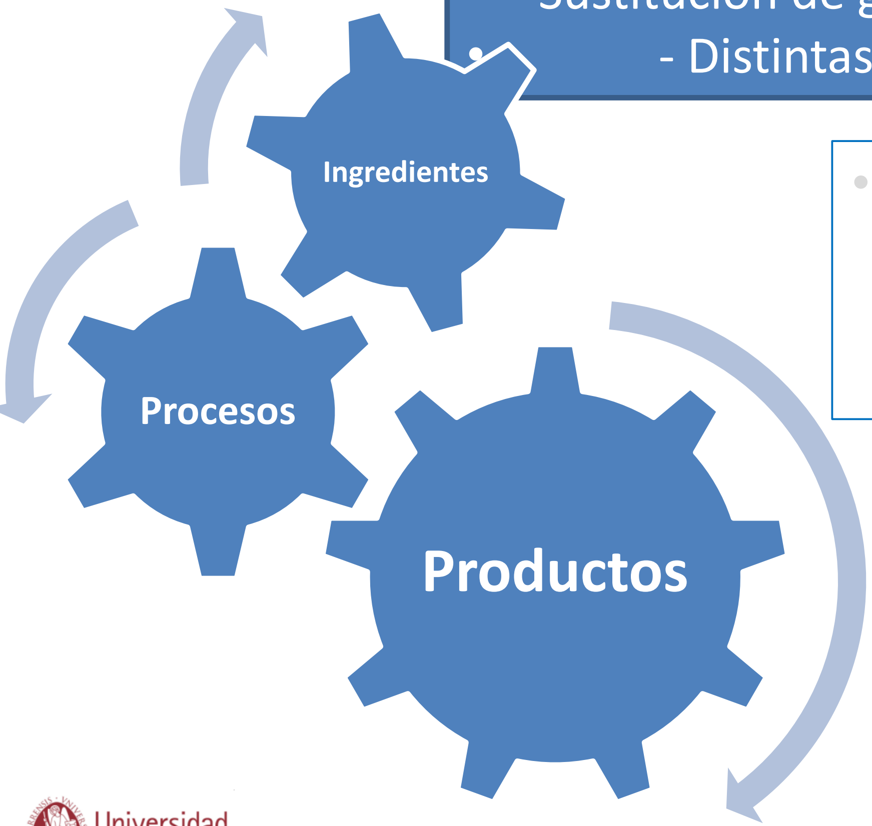
- - Distintas posibilidades tecnológicas



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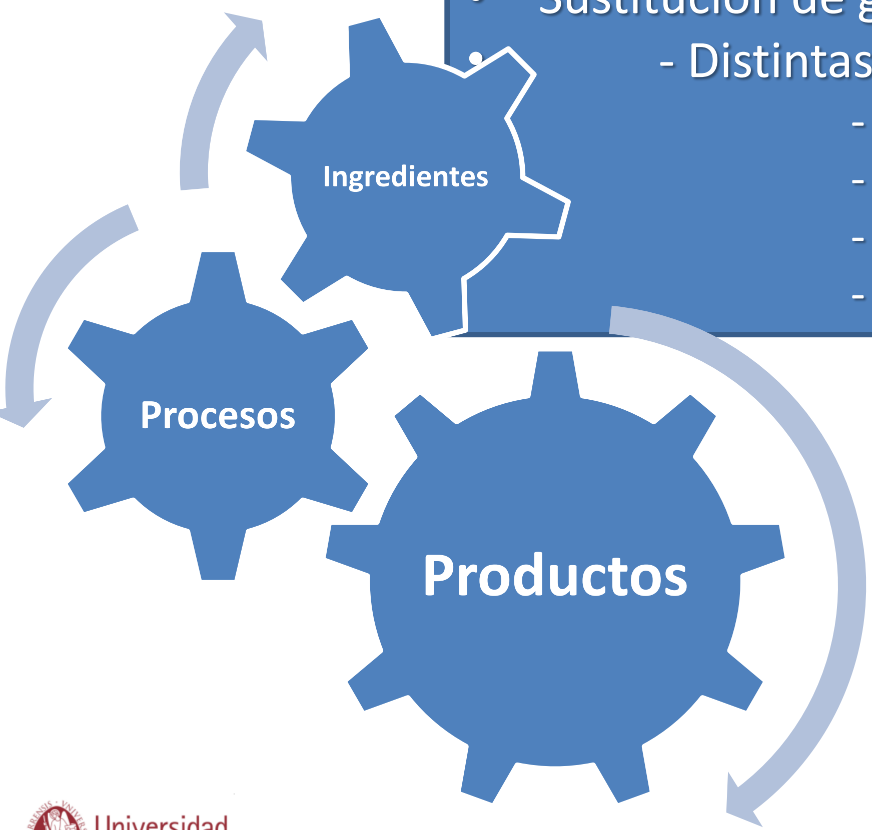
- - Distintas posibilidades tecnológicas:
  - - Adición directa del aceite
  - - Emulsiones o/w (aceites preemulsionados)
  - - Geles / geles emulsionados
  - - Encapsulación



- ➢ Mejora del perfil lipídico
- ➢ Disminución del contenido en colesterol

Lipid profiles of oils (g/100g fat)

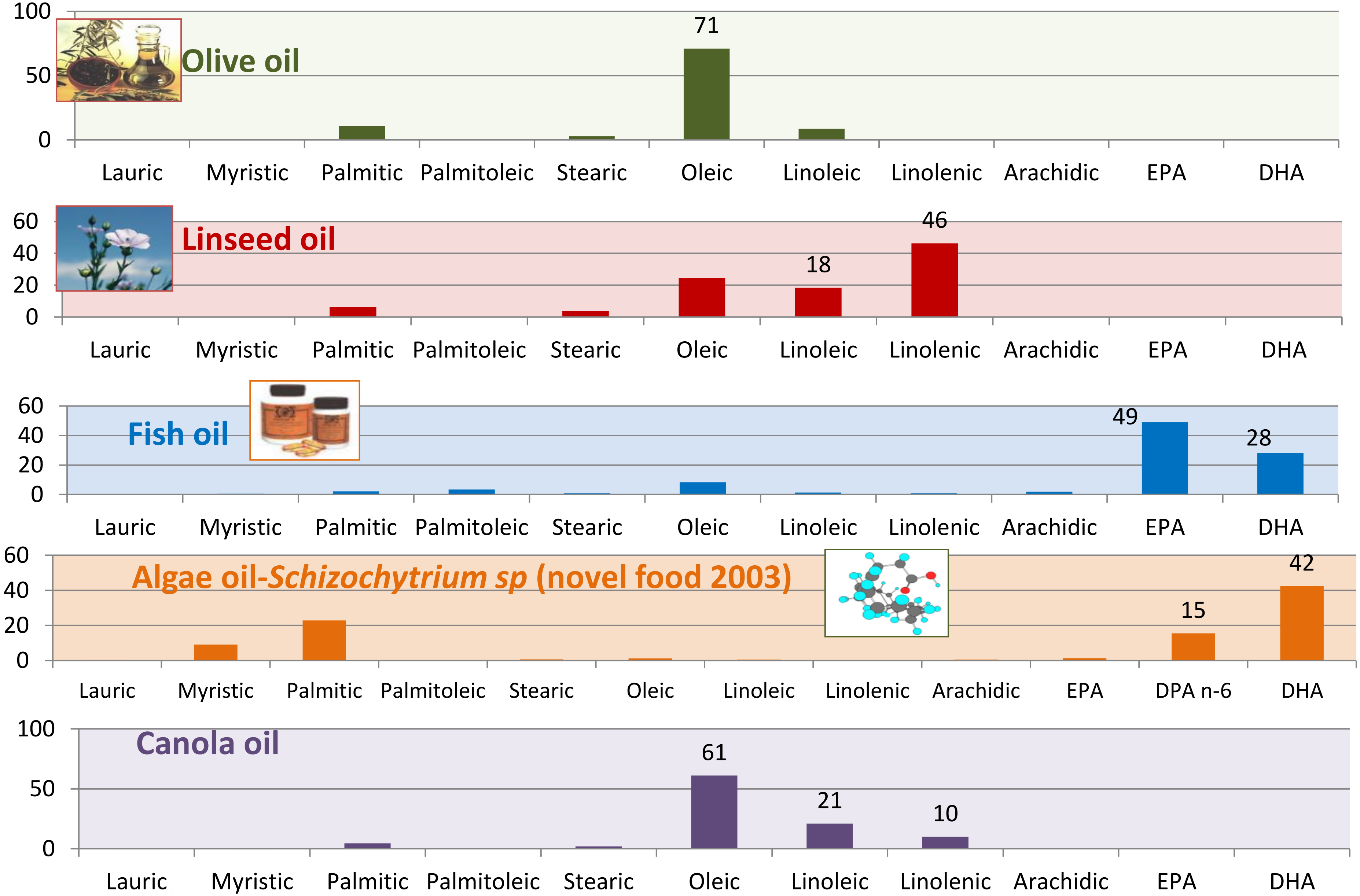


Table 1. Examples of application of oil-structuring strategies to improve the fat content of meat products.

Meat system	Oil	Oil-structuring strategy	Reference
Frankfurters	Palm, palm stearin, cottonseed and hazelnut oils, and their blended forms	Chemical interesterification	Özvural & Vural, 2008
Semy-dried fermented sausage	Palm and cottonseed oils	Chemical interesterification	Vural, 2003
Pork sausages	Blends of lard and rapeseed oil	Enzymatic interesterification	Cheong *et al.*, 2010
Frankfurters	Soy oil, flax oil and canola oil	Oleogel: ethylcellulose (10%)	Zetzl *et al.*, 2012
Meat suspensions	Mixture of virgin olive oil and sunflower oil	Oleogel: monoacylglycerols (0.5–2.5%), fatty alcohols (0.5–2.5%) or soy lecithin (2.5%)	Lupi *et al.*, 2012; Lupi, Gabriele, Seta, Baldino, & de Cindio, 2014
All-beef frankfurters and pork breakfast sausages	Canola oil	Oleogel: ethylcellulose (15%) or ethylcellulose (11%) and sorbitan monostearate (3.67%)	Wood, 2013
Frankfurters	Combination of olive, linseed and fish oils	Konjac-based oil bulking system	Salcedo-Sandoval, Cofrades, Ruiz-Capillas, Solas *et al.*, 2013
Dry fermented sausages	Combination of olive, linseed and fish oils	Konjac-based oil bulking system	Jimenez-Colmenero *et al.*, 2013
Pork patties	Combination of olive, linseed and fish oils	Konjac-based oil bulking system	Salcedo-Sandoval *et al.*, 2014
Meat batters	Olive oil	Alginate-based oil bulking system	Ruiz-Capillas *et al.*, 2013
Frankfurter	Olive oil	Alginate-based oil bulking system	Herrero, Ruiz-Capillas, *et al.*, 2014
Frankfurter	Combination of olive, linseed and fish oils	Emulsion gel: microbial transglutaminase (MTG)	Delgado-Pando, Cofrades, Ruiz-Capillas, Solas, *et al.* 2010
Bologna-type sausage	Linseed oil	Emulsion gel: k-carrageenan	Poyato *et al.*, 2014
Frankfurter	Olive oil	Emulsion gel: MTG, alginate or gelatin	Pintado, Herrero, *et al.*, in press; Pintado, Ruiz-Capillas, *et al.*, submitted for publication

Type of product	Reduction and/or Modification of the lipid fraction	Reference
Dutch style semi-dry fermented sausages	Partial replacement of pork back-fat with fish oil, canola oil, flaxseed oil added in different ways (pure, pre-emulsified, encapsulated).	Joskin et al. (2012) Pelser et al. (2007)
Spanish dry fermented sausages (chorizo)	Partial replacement of pork back-fat (50 and 80% of substitution) with konjac gel.	Ruiz-Capillas et al. (2012a) Ruiz-Capillas et al. (2012b)
	Low fat and n-3 PUFA enriched (olive, linseed and fish oil combination) with konjac gel.	Triki et al. (2013) Jimenez-Colmenero et al. (2013)
Spanish dry fermented sausages (chorizo de Pamplona)	Partial replacement of pork back-fat at different concentrations with different preemulsified oils : olive, soy, linseed, algae, fish.	Muguerza et al. (2001, 2003, 2004) Ansorena and Astiasarán (2004a,b) Valencia et al. (2006a,b, 2007) García-Iñiguez de Ciriano et al. (2009, 2010a,b) Beriain et al. (2011)
Spanish dry fermented sausages (salchichón)	Pork back-fat enriched in MUFA and PUFA (obtained from pigs fed with diets high in oleic and linoleic acids).	Hoz et al. (2004) Rubio et al. (2008)
Italian dry fermented sausages (salami)	Partial replacement of pork back-fat with olive oil.	Severini et al. (2003) Del Nobile et al. (2009)
Turkish fermented sausages (Sucuk)	Partial replacement of beef fat with walnut paste.	Ercoskun and Demirci-Ercoskun (2010)
	Partial replacement of beef fat with hazelnut oil.	Yildiz-Turp and Serdaroglu (2008) Ilikkan et al. (2009)
	Partial replacement of beef fat with olive oil.	Kayaardi and Gok (2004)
Greek fermented sausages	Partial replacement of pork back-fat with pre-emulsified olive oil.	Bloukas et al. (1997) Muguerza et al. (2002)
	Low fat sausages (10% fat).	Liaros et al. (2009)
	Low fat sausages (10% fat) obtained with a partial replacement of porkback fat with olive oil and carrageenan.	Koutsopoulos et al. (2008)

Fuente: Handbook of Fermented Meat & Poultry. 2015. Ed. W.Blackwell. Toldrá et al. (eds). Functional dry fermented sausages. Diana Ansorena and Iciar Astiasarán

Commercial meat products enriched in omega-3 fatty acids and comercial mixture to enrich cooked products (data reported on websites consulted in December 2011).

Company	Product	Website
Meat products		
Zakłady Mięsne NOWAK (Poland)	Turky potted ham Omega 3	http://www.zmnowak.pl/
Zakłady Mięsne NOWAK (Poland)	Hot-dogs Omega 3	http://www.zmnowak.pl/
Famous Fritz (Canada)	Hot dogs reduced in colesterol and enriched in omega-3	http://www.famousfritz.ca/omega3.html
Embutidos Cerrillo Fontecha (Spain)	Chorizo (dry fermented sausage)	http://www.cerrillofontecha.com/es/
Nematekas (Lietuva)	Boiled sausages and frankfurters made with linseed oil	http://www.pliusomega3.lt/
Serrano (Spain)	Cooked ham	http://www.cserrano.es/
Mixture for meat products		
Wiberg (Austria)	Omega-3 Mixture with fibre for cooked sausages: Combines a reduction of fat content (enabled via the fibre) with the addition of valuable Omega-3 fatty acids	http://en.wiberg.eu/

Ansorena & Astiasarán. Chapter 11. Food enriched with omega-3 fatty acids (Woodhead Publishing, 2013).

Adición directa

BURGER PATTIES

Avocado, sunflower and olive oils as replacers of pork back-fat in burger patties: Effect on lipid composition, oxidative stability and quality traits.

Estevez et al., Meat Science 90 (2012), 106-115.

1 kg Burger patties: 700g carne 180g agua 100g tocino 20g sal

Sustitución 50% tocino por 50g de aceite añadidos directamente

- Aguacate
- Girasol
- Oliva

Table 2
Chemical composition of cooked burger patties manufactured using avocado (A), sunflower (S) and olive (O) oils as replacers of pork back-fat.

	C	A	S	O	p-value[c]
Moisture[a]	61.84 ± 1.93	63.11 ± 0.96	63.39 ± 1.41	62.38 ± 0.65	0.202
Fat[a]	13.85 ± 0.38	14.80 ± 1.10	14.06 ± 0.56	14.02 ± 0.40	0.101
Protein[a]	22.09 ± 0.84	22.05 ± 0.67	21.70 ± 1.16	20.98 ± 1.41	0.137
Cholesterol[b]	79.60 ± 11.07	93.27 ± 11.25	94.25 ± 10.22	89.46 ± 10.78	0.341

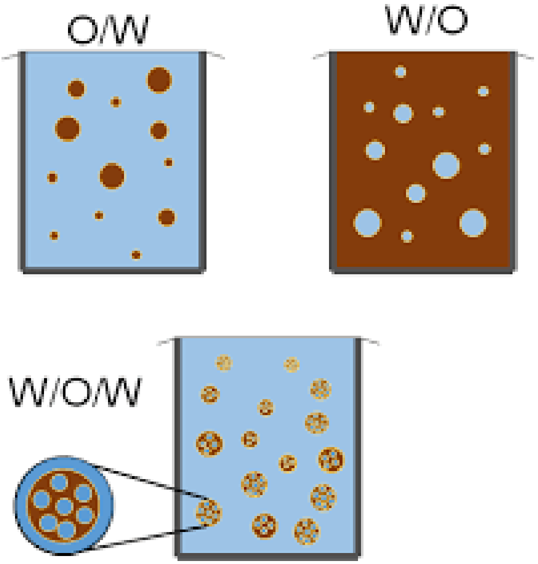
Results are expressed as means ± standard deviation.
[a] Expressed as g/100 g burger patty.
[b] Expressed as mg cholesterol/100 g burger patty.
[c] Statistical significance.

Table 3
Fatty acid profile of cooked burger patties manufactured using avocado (A), sunflower (S) and olive (O) oils as replacers of pork back-fat.

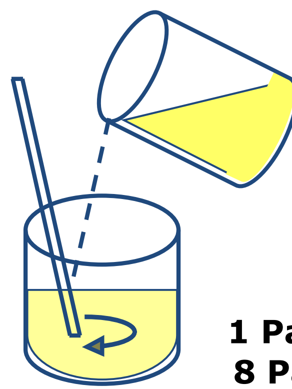
	C	A	S	O	p-value
ΣSFA[A]	$36.96^{a} \pm 0.91$	$25.36^{b} \pm 0.53$	$25.23^{b} \pm 2.91$	$25.28^{b} \pm 0.74$	<0.001
ΣMUFA[B]	$47.02^{c} \pm 0.66$	$55.87^{b} \pm 0.32$	$36.47^{d} \pm 0.75$	$62.18^{a} \pm 1.60$	<0.001
ΣPUFA[C]	$16.02^{c} \pm 0.50$	$18.78^{b} \pm 0.46$	$38.30^{a} \pm 2.22$	$12.53^{d} \pm 1.05$	<0.001
ΣlcPUFA[D]	3.13 ± 0.26	2.67 ± 0.59	2.86 ± 0.32	2.64 ± 0.86	0.076
Σ n−3	1.85 ± 0.15	1.87 ± 0.32	1.83 ± 0.21	1.77 ± 0.59	0.243
Σ n−6	$14.17^{c} \pm 0.40$	$16.91^{b} \pm 0.17$	$36.47^{a} \pm 2.04$	$10.76^{d} \pm 0.53$	<0.001
n6/n3	$7.71^{bc} \pm 0.56$	$9.30^{b} \pm 1.70$	$20.07^{a} \pm 1.56$	$6.51^{c} \pm 1.62$	<0.001
AI[E]	$0.41^{a} \pm 0.01$	$0.25^{b} \pm 0.01$	$0.23^{b} \pm 0.03$	$0.24^{b} \pm 0.01$	<0.001

Results are expressed as means ± standard deviation. Values with a different letter ($^{a-d}$) within a row are significantly different ($p<0.05$).
[A] Saturated fatty acids (SFA).
[B] Monounsaturated fatty acids (MUFA).
rated fatty acids (PUFA).

Sistema constituido por dos fases líquidas inmiscibles, una de las cuales se dispersa a través de la otra en forma de gotas



PREPARACIÓN DE LA EMULSIÓN



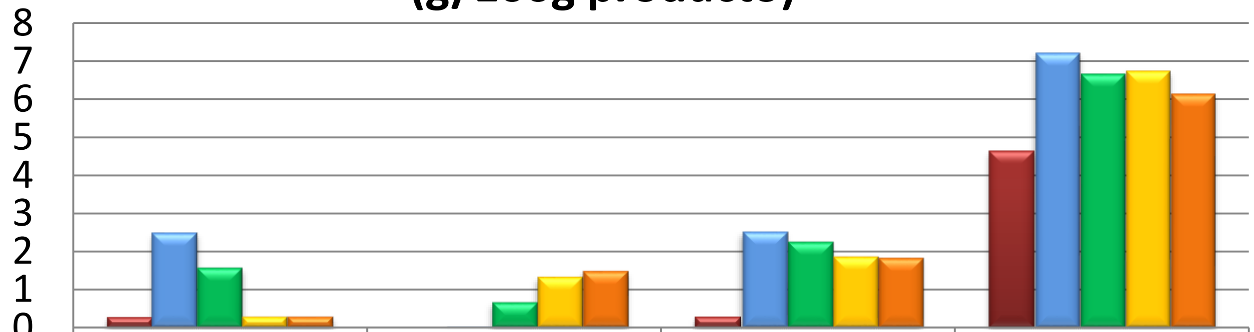
10 Partes de aceite

1 Parte de proteína de soja
8 Partes de agua (caliente)

Bloukas et al., 1997

Sustitución de tocino de cerdo por emulsión O/W rica en w-3

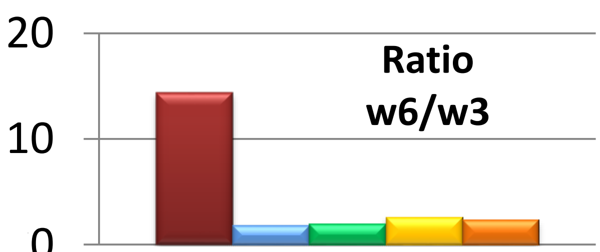
(g/100g producto)



	a-linolénico	EPA+DHA	w-3	PUFA
Control	0,28	0,01	0,29	4,64
Lino	2,5	0,03	2,53	7,22
Lino +Alga	1,58	0,67	2,26	6,67
Alga (15%)	0,29	1,34	1,87	6,75
Alga (25%)	0,29	1,49	1,84	6,15

"Alto contenido en AG w-3"

18.6g embutido
100% Recomendación EFSA (EPA+DHA)



García-Iñiguez de Ciriano et al. (2009, 2010) – Meat Sci.
Valencia et al. (2007) – Food Chem

Food Research International 69 (2015) 133–140

Contents lists available at ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Role of *Melissa officinalis* in cholesterol oxidation: Antioxidant effect in model systems and application in beef patties

Blanca Barriuso [a], Diana Ansorena [a,*], Maria Isabel Calvo [b], Rita Yolanda Cavero [c], Iciar Astiasarán [b]

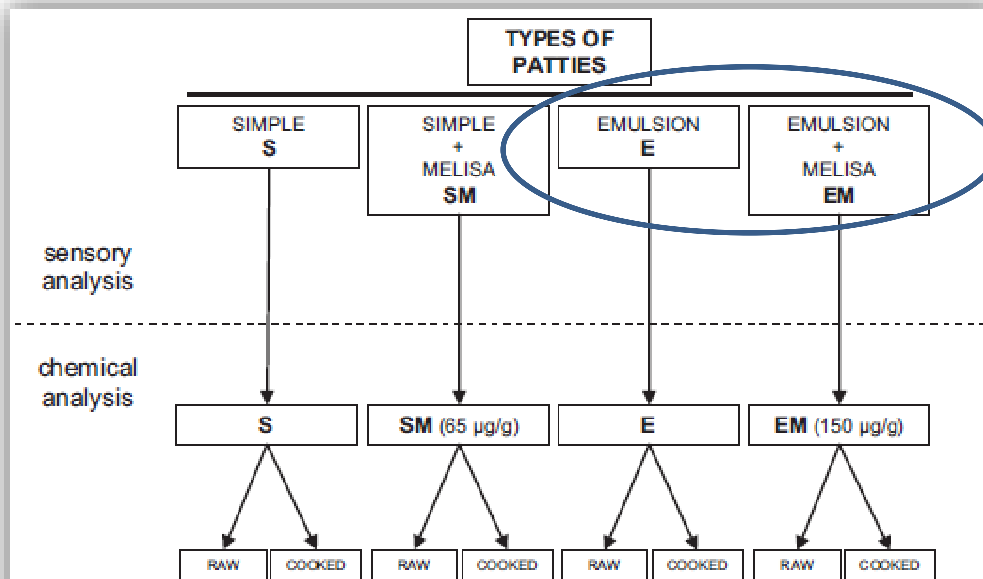


Fig. 1. Experimental design for the beef patty study.

Emulsiones

Food Research International 69 (2015) 133–140

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Role of *Melissa officinalis* in cholesterol oxidation: Antioxidant effect in model systems and application in beef patties

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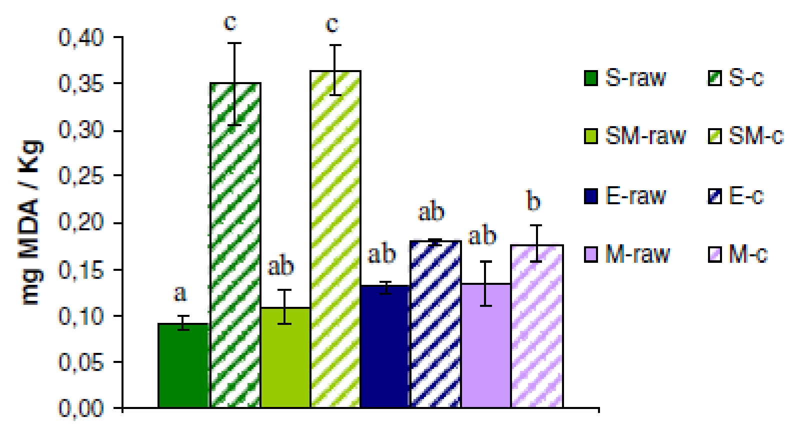

Fig. 5. TBARS of beef patties (S, SM, E and EM). For each type of patty, the filled bar indicates raw sample and the striped bar indicates cooked sample. Different letters denote significant differences among samples ($p < 0.05$).

Emulsiones

Meat Science 88 (2011) 705–711

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

“High in omega-3 fatty acids” bologna-type sausages stabilized with an aqueous-ethanol extract of *Melissa officinalis*

Izaskun Berasategi [a], Sheila Legarra [a], Mikel García-Íñiguez de Ciriano [a], Sheyla Rehecho [b], Maria Isabel Calvo [b], Rita Yolanda Cavero [c], Íñigo Navarro-Blasco [d], Diana Ansorena [a,*], Iciar Astiasarán [a]

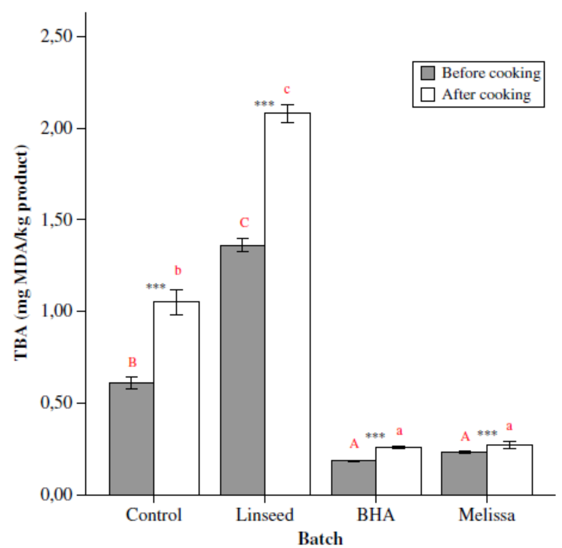

Fig. 2. TBARs values before and after the cooking process of the four types of Bologna-type sausages (mg malondialdehyde/kg product). Standard deviation bars are indicated (n=3). Level of significance for the Student t test that compares products before and after cooking: ***; p<0.001. Different capital letters denote significant differences among batches before cooking and different lowercase letters denote significant differences among batches after cooking (p<0.05).

Research Article

SCI

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(wileyonlinelibrary.com) DOI 10.1002/jsfa.6409

Reduced-fat bologna sausages with improved lipid fraction

Izaskun Berasategi,[a] Mikel García-Íñiguez de Ciriano,[a] Íñigo Navarro-Blasco,[b] Maria Isabel Calvo,[c] Rita Yolanda Cavero,[d] Iciar Astiasarán[a] and Diana Ansorena[a*]

Fuente lipídica:
100% Aceite de lino O/W

Meat Science 96 (2014) 1185–1190

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Healthy reduced-fat Bologna sausages enriched in ALA and DHA and stabilized with *Melissa officinalis* extract

Izaskun Berasategi [a], Íñigo Navarro-Blasco [b], Maria Isabel Calvo [c], Rita Yolanda Cavero [d], Iciar Astiasarán [a], Diana Ansorena [a,*]

Fuente lipídica:
Aceite de lino y alga O/W

- Reducido en energía
- Reducido en grasa
- Bajo en grasa saturada
- Alto contenido en omega-3

4% grasa

Estructuras tridimensionales sólidas o semisólidas capaces de inmovilizar una fase líquida

- **Konjac**-based oil bulking system containing 20% (w/w) of a combination of olive, linseed and fish oils.

Salcedo-Sandoval et al. (2013). Meat Sci., 93, 757-766

- **Carrageenan** gelled emulsion with 40% linseed oil.

Poyato et al. (2014). Meat Science, 98, 615-621.

- **Alginate**-based oil bulking system containing 55% (w/w) of olive oil and prepared with:

a) alginate/inulin; b) alginate/dextrin.

Herrero et al. (2014). J Agric Food Chem, 62, 5963–5971

- **Filled hydrogel** particles with fish oil

Salcedo-Sandoval et al. (2015). Meat Science, 110, 6160-168.

Producto cocido- bologna

Gel emulsionado:
Fase oleosa: 40 g/100 g emulsion conteniendo Polysorbate 80 como surfactante (0.12 g/100 g oil)
Fase acuosa: 60 g/100 g emulsión conteniendo 1.5g de carragenato

High omega-3: >0,6g a-linolénico/100g y 100kcal (aceite de lino)

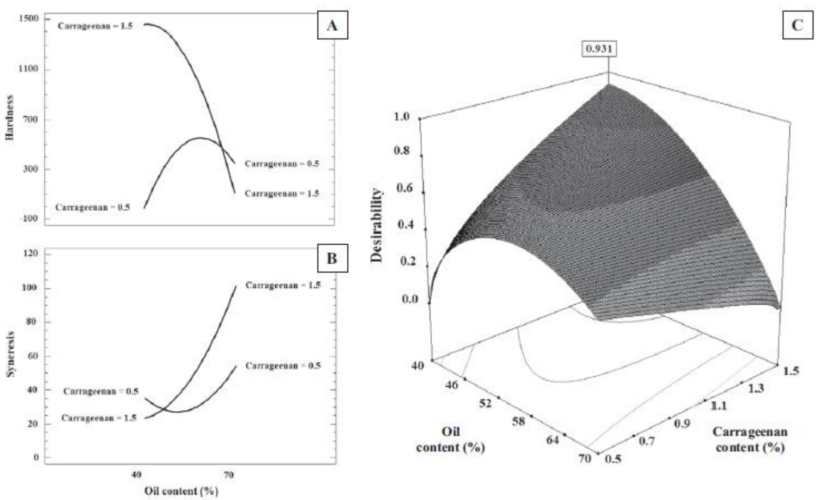


Fig. 1. (A) Interaction plots of the hardness (g) and (B) the syneresis (%). (C) Response surface plot of the multiple optimization of hardness and syneresis.

Table 2
Chemical composition (g/100 g product) of the different formulated Bologna-type sausages.

	Control	Emulsion	Gel
Moisture	69.09 ± 0.07^{a}	70.87 ± 0.06^{b}	71.48 ± 0.07^{c}
Protein	15.06 ± 0.65^{a}	13.91 ± 0.78^{a}	14.88 ± 0.57^{a}
Fat content	13.24 ± 0.15^{b}	12.09 ± 0.15^{a}	11.89 ± 0.04^{a}
Caprilic C8:0	nd	nd	nd
Capric C10:0	0.03 ± 0.01^{b}	0.02 ± 0.01^{a}	0.02 ± 0.01^{a}
Lauric C12:0	0.02 ± 0.01^{b}	0.01 ± 0.00^{a}	0.01 ± 0.00^{a}
Myristic C14:0	0.17 ± 0.01^{b}	0.09 ± 0.01^{a}	0.10 ± 0.01^{a}
Palmitic C16:0	3.08 ± 0.01^{c}	2.11 ± 0.01^{b}	2.06 ± 0.01^{a}
t-Palmitoleic C16:1	0.01 ± 0.00^{b}	0.01 ± 0.00^{a}	0.01 ± 0.00^{a}
Palmitoleic C16:1	0.22 ± 0.01^{c}	0.16 ± 0.01^{b}	0.15 ± 0.01^{a}
Stearic C18:0	1.67 ± 0.01^{c}	1.16 ± 0.01^{b}	1.12 ± 0.01^{a}
Elaidic C18:1	0.07 ± 0.01^{c}	0.04 ± 0.01^{b}	0.03 ± 0.01^{a}
Oleic C18:1 (ω-9)	5.10 ± 0.02^{c}	4.29 ± 0.01^{b}	4.00 ± 0.01^{a}
c-Vaccenic C18:1 (ω-7)	0.34 ± 0.01^{c}	0.27 ± 0.01^{b}	0.25 ± 0.01^{a}
t-Linoleic C18:2	nd	nd	nd
c-*t* linoleic C18:1	0.01 ± 0.00^{b}	0.01 ± 0.00^{a}	0.01 ± 0.00^{a}
t-c linoleic C18:1	0.01 ± 0.00^{b}	0.01 ± 0.00^{a}	0.01 ± 0.00^{a}
Linoleic C18:2 (ω-6)	2.23 ± 0.01^{c}	1.90 ± 0.01^{a}	1.93 ± 0.01^{b}
Arachidic C20:0	nd	0.01 ± 0.00^{a}	0.01 ± 0.00^{a}
γ-linolenic C18:3 (ω-6)	0.01 ± 0.00^{c}	0.01 ± 0.00^{a}	0.01 ± 0.00^{b}
Eicosenoic C20:1 (ω-9)	0.10 ± 0.01^{c}	0.07 ± 0.01^{b}	0.07 ± 0.01^{a}
α-linolenic C18:3 (ω-3)	0.11 ± 0.01^{a}	1.84 ± 0.01^{b}	1.99 ± 0.01^{c}
Behenic C22:0	nd	nd	nd
Brassidic C20:1	nd	nd	nd
Erucic C22:1	nd	nd	nd
Eicosatrienoic C20:3 (ω-3)	0.02 ± 0.00^{a}	0.01 ± 0.00^{a}	0.01 ± 0.00^{a}
Arachidonic C20:4 (ω-6)	0.04 ± 0.01^{a}	0.04 ± 0.01^{a}	0.05 ± 0.01^{b}
Eicosapentaenoic C22:5 (ω-3)	nd	0.01 ± 0.00^{a}	0.01 ± 0.00^{a}
Nervonic C24:1 (ω-9)	nd	nd	nd
Docosatrienoic C22:3 (ω-3)	nd	nd	nd
Docosapentaenoic C22:5 (ω-6)	nd	0.02 ± 0.01^{a}	0.02 ± 0.01^{a}
Lignoceric C24:0	nd	nd	nd
SFA	4.97 ± 0.02^{c}	3.41 ± 0.01^{b}	3.33 ± 0.01^{a}
MUFA	5.76 ± 0.02^{c}	4.79 ± 0.01^{b}	4.48 ± 0.01^{a}
PUFA	2.41 ± 0.01^{a}	3.82 ± 0.02^{b}	4.01 ± 0.01^{c}
ω-3	0.12 ± 0.01^{a}	1.87 ± 0.02^{b}	2.03 ± 0.01^{b}
ω-6	2.28 ± 0.01^{c}	1.95 ± 0.01^{a}	1.98 ± 0.01^{b}
ω-6/ω-3	14.08^{b}	0.78^{a}	0.73^{a}
Trans	0.11 ± 0.01^{b}	0.07 ± 0.01^{a}	0.05 ± 0.01^{a}

[1]Different letters in the same row denote significant differences among samples ($p < 0.05$). nd: not detected.

Poyato et al., 2014. **Optimization** of a gelled emulsion intended to supply ω-3 fatty acids into meat products by means of response surface methodology. Meat Science, 98, 615-621.

Producto fresco - hamburguesas

Gel emulsionado:
Fase oleosa: 40 g/100 g emulsion conteniendo Polysorbate 80 como surfactante (0.12 g/100 g oil)
Fase acuosa: 60 g/100 g emulsión conteniendo 1.5g de carragenato

Table 1
Scores ± standard deviation of a sensory multiple comparison tests for cooked samples between control (G0) and the different level of substitution samples. A total of 11 trained panellist participated.

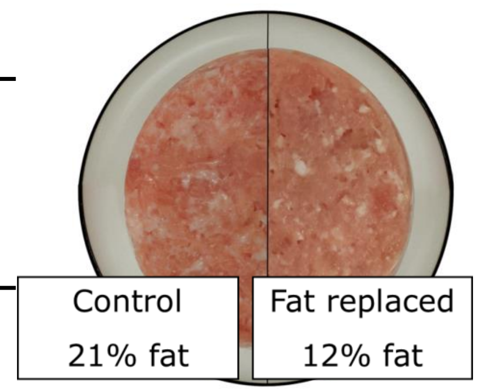
	G25	G50	G75	G100	p-value
Odour	5.0 ± 1.0	4.4 ± 1.1	4.2 ± 1.5	4.4 ± 0.9	p > 0.05
Colour	4.8 ± 0.6	4.7 ± 0.7	4.7 ± 0.7	4.8 ± 0.4	p > 0.05
Taste	4.5 ± 0.8	4.5 ± 1.0	5.1 ± 1.1	4.8 ± 1.0	p > 0.05
Hardness	4.6 ± 1.3	5.0 ± 1.2	4.6 ± 1.2	4.6 ± 0.8	p > 0.05
Juiciness	4.5 ± 1.0	4.4 ± 1.0	4.6 ± 1.2	5.2 ± 1.4	p > 0.05
Fatness	5.3 ± 0.9	5.0 ± 1.0	4.4 ± 1.0	4.6 ± 1.2	p > 0.05

The p-value corresponds to ANOVA test among the substituted products.
Scores: 1. very much less; 2. much less; 3. considerably less; 4. slightly less; 5. not differences; 6. slightly more; 7. considerably more; 8. much more; 9. very much more.

Cocinado: mayor susceptibilidad oxidación

	Energy decrease (%)	Energy provided by protein (%)	Fat decrease (%)	SFA+trans decrease (%)	PUFA+MUFA Content (%)	PUFA+MUFA Energy provided (%)
G0		**27.9** [2]			**61.4**	**44.2**
G25	**10.8**	**31.1** [2]	**14.1**	**20.5**	**64.2**	**44.5**
G50	**16.5**	**33.5** [2]	**22.9**	**34.4** [4]	**67.1**	**44.6**
G75	**23.9**	**35.0** [2]	**31.4** [3]	**49.2** [4]	**71.4**	**46.3** [5]
G100	**30.0** [1]	**26.6** [2]	**41.4** [3]	**61.7** [4]	**74.5**	**45.1** [5]

[1]"energy reduced", [2]"high protein", [3]"reduced fat", [4]"reduced saturated fat", [5]"high unsaturated fat".
Regulation (EC) Nº 1924/2006



A new polyunsaturated gelled emulsion as replacer of pork back-fat in burger patties: Effect on lipid composition, oxidative stability and sensory acceptability. Poyato et al., 2015. LWT - Food Science and Technology 62, 1069-1075

Producto curado- chorizo

Gel emulsionado:
Fase oleosa: 40 g/100 g emulsion
conteniendo Polysorbate 80 como surfactante
(0.12 g/100 g oil)
Fase acuosa: 60 g/100 g emulsión
conteniendo 1.5g de carragenato

Fuente lipídica:
100% Aceite de lino

Table 1
Main ingredients for the 4 types of dry fermented sausages.

Samples	Fat replaced (%)	Pork meat (g)	Pork back fat (g)	Gelled emulsion (g)
C	0	4500	1500	–
SUB 1	26.3	4500	1105.5	394.5
SUB 2	32.8	4500	1008	492
SUB 3	39.5	4500	907.5	592.5

Amounts calculated for 6 kg of each product.

Table 4
Parameters related to nutrition claims in the different formulations of dry fermented sausages.

Samples	Energy provided by protein (kcal/100 kcal)	Omega 3- fatty acids (g α-linolenic/100 g)	Omega 3- fatty acids (g α-linolenic/100 kcal)
Control	21.2[1]	0.35	0.08
SUB1	22.0[1]	1.81	0.45[2]
SUB2	21.6[1]	2.19	0.57[2]
SUB3	20.4[1]	2.39	0.64[2,3]

Each superscript number refers to the nutrition claims listed below.
[1] High protein.
[2] Source of omega 3-fatty acids.
[3] High omega 3- fatty acids.

Linseed oil gelled emulsion: a successful fat replacer in dry fermented sausages. Alejandre et al., 2016. Meat Sci 121, 107-113.

Table 1
Formulation (g) of frankfurters.

Sample	Meat	Backfat	Substituents			Water
			KG	OKM	OWE	
C	2281.25	762.56	–	–	–	843.71
F/KG	2381.74	315.97	762.56	–	–	427.26
F/OKM	2421.93	137.33	–	762.56	–	565.70
F/OWE	2421.93	137.33	–	–	304.00	1024.26
F/OWE+KG	2421.93	137.33	220.40	–	304.00	803.86

Oil combination: olive (44.39%), linseed (37.87%) and fish (17.74%) oils.

KG: konjac (50g) water (648 mL),i-carrageenan (10 g), starch powder (30 g in 162 mL water), $Ca(OH)_2$ solution (100 mL al 1%) .

OKM (Oil-in-konjac matrix): konjac matrix containing 20% of the oil combination.

OWE (Oil-in-water emulsion): 10/8/1 (O/W/Sodium Caseinate) containing 52.63% of the oil combination.

Table 3
Fatty acid profile (g/100 g product) and nutritional significant ratios of different frankfurters.

Fatty acid	Frankfurters		
	With normal fat content	With reduced fat content	With reduced and improved fat content
	C	F/KG	F/OKM, F/OWE, F/OWE+KG
Myristic C 14:0	0.22 ± 0.00^{b}	0.12 ± 0.00^{a}	1.11 ± 0.00^{a}
Palmitic C16:0	4.09 ± 0.03^{c}	2.15 ± 0.01^{b}	1.77 ± 0.02^{a}
Stearic C18:0	2.09 ± 0.08^{c}	1.05 ± 0.00^{b}	0.85 ± 0.02^{a}
Arachidic C20:0	–	–	0.03 ± 0.01
Other SFAs	0.05 ± 0.00^{c}	0.03 ± 0.00^{b}	0.02 ± 0.00^{a}
Σ SFA	6.45 ± 0.10^{c}	3.34 ± 0.00^{b}	2.79 ± 0.04^{a}
Palmitoleic C16:1	0.34 ± 0.00^{b}	0.21 ± 0.00^{a}	0.22 ± 0.00^{a}
Oleic C18:1n9	8.78 ± 0.09^{c}	4.49 ± 0.02^{b}	4.43 ± 0.01^{a}
Vaccenic C18:1n7c	0.64 ± 0.01^{c}	0.36 ± 0.01^{b}	0.34 ± 0.00^{a}
Eicosenoic C20:1n9c	0.25 ± 0.00^{c}	0.12 ± 0.00^{b}	0.08 ± 0.00^{a}
Σ MUFA	10.01 ± 0.10^{c}	5.18 ± 0.02^{b}	5.07 ± 0.01^{a}
Linoleic C18:2n6	1.41 ± 0.02^{c}	0.76 ± 0.00a	0.83 ± 0.00^{b}
Linolenic C18:3n3	0.08 ± 0.00^{b}	0.04 ± 0.00^{a}	0.88 ± 0.00^{c}
Eicosadienoic C20:2n6	0.08 ± 0.00^{c}	0.04 ± 0.00^{b}	0.03 ± 0.00^{a}
Eicosapentaenoic C20:5n3	–	–	0.12 ± 0.00
Docosahexaenoic C22:6n3	–	–	0.07 ± 0.00
Other PUFAs	0.07 ± 0.00^{c}	0.04 ± 0.00^{a}	0.05 ± 0.00^{b}
Σ PUFA	1.64 ± 0.02^{b}	0.88 ± 0.00^{a}	1.98 ± 0.00^{c}
PUFA/SFA	0.26 ± 0.01^{a}	0.26 ± 0.00^{a}	0.71 ± 0.01^{b}
Σ n−3	0.16 ± 0.00^{a}	0.08 ± 0.00^{a}	1.12 ± 0.00^{b}
Σ n−6	1.49 ± 0.02^{c}	0.80 ± 0.00^{a}	0.85 ± 0.00^{b}
n−6/n−3	9.61 ± 0.18^{b}	9.58 ± 0.07^{b}	0.76 ± 0.00^{a}
Atherogenic index	0.42 ± 0.01^{b}	0.43 ± 0.00^{b}	0.31 ± 0.00^{a}
Thrombogenic index	1.01 ± 0.03^{b}	0.99 ± 0.00^{b}	0.36 ± 0.01^{a}

Sample denomination: C, control sample prepared with normal fat content; F/KG, reduced fat content frankfurter prepared by partial replacement of pork backfat by KG. Since the three frankfurters (F/OKM, F/OWE and F/OWE+KG) were formulated with the same lipid material, data reported are the mean values of these frankfurters. Means±SD. Different letters in the same row (a, b, c) indicate significant differences ($P<0.05$).

OKM

- Reduced fat
- Improved lipid profile

Healthier oils stabilized in konjac matrix as fat replacers in n−3 PUFA enriched frankfurters. Salcedo-Sandoval et al., 2013. Meat Sci., 93, 757-766.

Table 1
Formulation (%) of frankfurters.

Sample	Meat	Backfat	Strategy used to incorporate the fish oil			Water
			Liquid oil	O/W emulsion	Filled hydrogel particles	
F/C	58.87	2.16				33.96
F/O	58.87	–	2.00			34.12
F/E	58.87	–		23.50		12.62
F/H	58.87	–			23.50	12.62

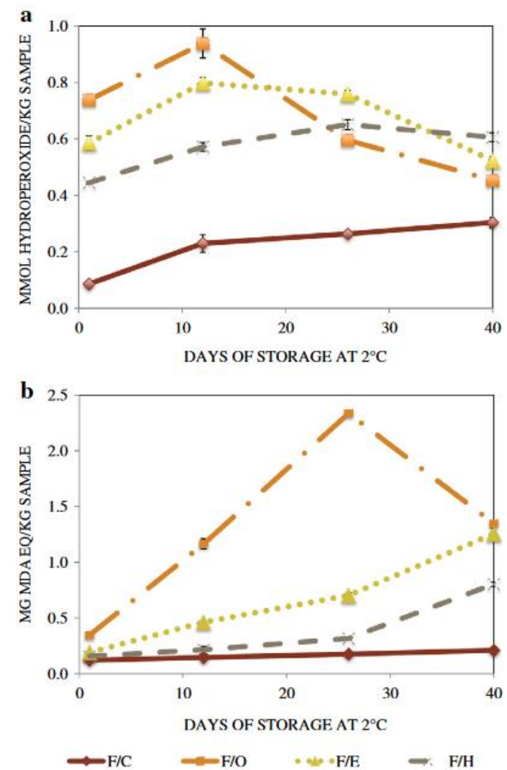
Sample denomination: F/C, control frankfurter with all pork fat; F/O, frankfurter with fish oil added directly, as liquid form; F/E, frankfurter with fish oil added stabilized in an O/W emulsion; F/H, frankfurter with fish oil incorporated in filled hydrogel particles. O/W emulsion and filled hydrogel particles contained 8.50% fish oil. The following were also added to all samples: 2.50% soy protein isolate; 1.70% sodium chloride; 0.50% flavouring; 0.30% sodium tripolyphosphate and 0.012% sodium nitrite.

Table 3
Fatty acid profile (mg/100 g product) and nutritional significant ratios of frankfurters.

Fatty acid	F/C	F/O	F/E	F/H
C14:0	$41.87^{2} \pm 0.90$	$19.97^{1} \pm 2.65$	$20.90^{1} \pm 1.06$	$21.19^{1} \pm 0.82$
C16:0	$871.42^{2} \pm 12.19$	$766.10^{1} \pm 15.83$	$826.44^{2} \pm 15.68$	$902.14^{3} \pm 20.44$
C18:0	$538.02^{3} \pm 20.81$	$243.02^{2} \pm 6.58$	$282.33^{1} \pm 12.08$	$298.16^{1} \pm 6.24$
Other SFAs	$78.43^{1} \pm 17.27$	$105.90^{2} \pm 1.32$	$115.57^{2} \pm 7.60$	$138.62^{3} \pm 5.59$
∑ SFA	$1491.49^{4} \pm 6.75$	$1134.99^{1} \pm 23.79$	$1245.24^{2} \pm 18.84$	$1360.11^{3} \pm 31.47$
C16:1	$72.26^{1} \pm 3.63$	$315.50^{2} \pm 3.42$	$474.63^{3} \pm 25.32$	$517.85^{4} \pm 29.78$
C18:1n9	$1774.16^{3} \pm 46.64$	$884.37^{1} \pm 18.98$	$1027.19^{2} \pm 42.92$	$1025.76^{2} \pm 43.07$
C18:1n7c	$122.00^{1} \pm 12.27$	$144.03^{2} \pm 1.63$	$159.48^{2} \pm 7.38$	$184.34^{3} \pm 4.99$
C20:1n9c	$41.91^{3} \pm 2.60$	$33.04^{1} \pm 0.59$	$37.95^{2} \pm 0.60$	$43.76^{3} \pm 1.10$
Other MUFA	$38.92^{1} \pm 4.93$	$60.34^{2} \pm 0.18$	$71.60^{3} \pm 8.88$	$81.82^{3} \pm 3.20$
∑ MUFA	$2049.25^{3} \pm 66.65$	$1437.26^{1} \pm 24.23$	$1770.84^{2} \pm 34.50$	$1853.53^{2} \pm 71.42$
C18:2n6	$400.84^{3} \pm 13.43$	$260.80^{1} \pm 2.73$	$311.42^{2} \pm 18.64$	$288.23^{2} \pm 6.42$
C18:3n3	$20.46^{1} \pm 0.97$	$26.23^{2} \pm 0.30$	$29.67^{3} \pm 1.53$	$34.79^{4} \pm 0.42$
C20:5n3	–	$417.42^{1} \pm 8.23$	$466.67^{2} \pm 24.41$	$539.10^{3} \pm 22.15$
C22:6n3	–	$275.17^{1} \pm 35.29$	$294.47^{12} \pm 11.91$	$328.52^{2} \pm 12.67$
Other PUFA	$85.57^{1} \pm 4.99$	$174.93^{2} \pm 1.83$	$222.62^{3} \pm 13.78$	$212.29^{3} \pm 8.21$
∑ PUFA	$506.87^{1} \pm 19.35$	$1154.55^{2} \pm 32.99$	$1324.85^{3} \pm 49.55$	$1402.93^{3} \pm 42.02$
∑ n−6	$440.87^{3} \pm 19.80$	$353.22^{1} \pm 3.22$	$443.43^{3} \pm 22.97$	$406.56^{2} \pm 6.69$
∑ n−3	$66.00^{1} \pm 1.78$	$801.34^{2} \pm 30.15$	$881.42^{3} \pm 40.05$	$996.37^{4} \pm 38.72$
∑ n−3 LCPUFA	–	$692.59^{1} \pm 29.14$	$761.14^{2} \pm 35.54$	$867.62^{3} \pm 34.80$
n−6/n−3	$6.69^{2} \pm 0.39$	$0.44^{1} \pm 0.01$	$0.50^{1} \pm 0.03$	$0.41^{1} \pm 0.01$
PUFA/SFA	$0.34^{1} \pm 0.01$	$1.02^{2} \pm 0.05$	$1.06^{2} \pm 0.05$	$1.03^{2} \pm 0.01$
Atherogenic index	$0.40^{3} \pm 0.02$	$0.33^{2} \pm 0.01$	$0.29^{1} \pm 0.01$	$0.30^{12} \pm 0.01$
Thrombogenic index	$0.98^{2} \pm 0.04$	$0.31^{1} \pm 0.01$	$0.30^{1} \pm 0.01$	$0.30^{1} \pm 0.00$

For sample denomination see Table 1. Means ± SD. Different numbers in the same row indicate significant differences ($P < 0.05$).

Pork | Fish-Liquid | Fish-O/W | Fish-Hydrogel



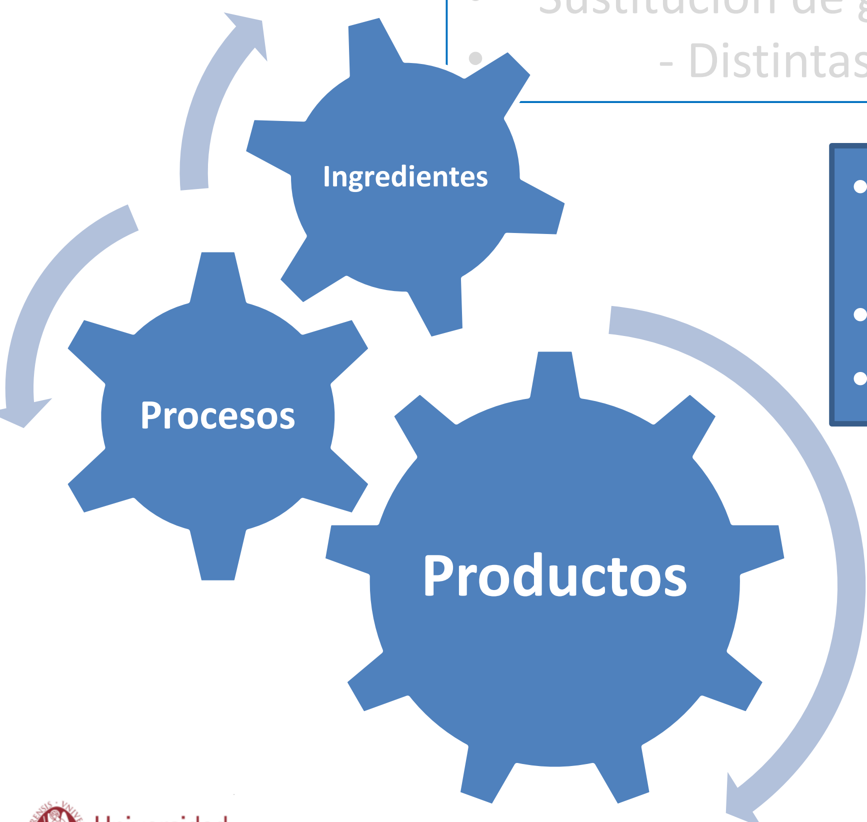
Filled hydrogel particles as a delivery system for n-3 long chain PUFA in low fat frankfurters: consequences for product characteristics with special reference to lipid oxidation.

Salcedo-Sandoval et al. (2015). Meat Science, 110, 160-168.

Reformulación de productos procesados

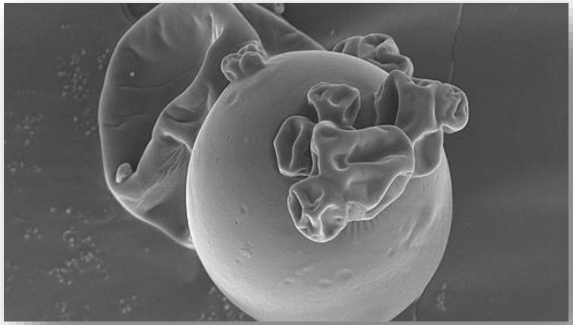
- Reducción de grasa (energía)
- - Sustitución de la grasa por componentes menos energéticos: agua, hidratos de carbono (fibra).

- Sustitución de grasa animal por aceites/grasas más saludables:
- - Distintas posibilidades tecnológicas



- Enriquecimiento de los productos con compuestos bioactivos lipídicos:
- - AGP omega-3 de apm (EPA, DHA)
- - Esteroles vegetales.

Microcápsulas de omega-3 para enriquecer productos cárnicos



Microcápsulas producidas mediante spray-drying se incorporan a la masa de los nuggets como un ingrediente.

- No hay alteración de las cualidades físico-químicas
- Buenas propiedades sensoriales
- La microencapsulación ha demostrado ser una técnica efectiva de protección frente a la oxidación de estos ácidos grasos.
- Conservación óptima de las microcápsulas: tres meses y a temperatura ambiente.

Jiménez-Martín et al. UNEX

ALIMENTACIÓN ÓPTIMA

Consumer views on "healthier" processed meat

Liran Christine Shan and Aine Regan
School of Public Health, Physiotherapy and Sports Science, University College Dublin, Dublin, Ireland and Institute of Food and Health, University College Dublin, Dublin, Ireland
Frank J. Monahan and Chenguang Li
School of Agriculture and Food Science, University College Dublin, Dublin, Ireland, and
Celine Murrin, Fiona Lalor, Patrick G. Wall and Aine McConnon
School of Public Health, Physiotherapy and Sports Science, University College Dublin, Dublin, Ireland and Institute of Food and Health, University College Dublin, Dublin, Ireland

British Food Journal 118, 1712-1730 (2016)

"Many of the participants expressed an openness to purchase this food product if taste and price remained uncompromised"

Trends in Food Science & Technology
Volume 39, Issue 1, September 2014, Pages 4–17

Review

Healthy processed meat products – Regulatory, reformulation and consumer challenges

S. Grasso, N.P. Brunton, J.G. Lyng, F. Lalor, F.J. Monahan
UCD School of Agriculture and Food Science, University College Dublin, Dublin 4, Ireland

“La reformulación de productos cárnicos puede atraer a consumidores interesados en disminuir los posibles riesgos asociados al consumo de carnes procesadas”

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Muchas gracias por su atención