UNIVERSITÀ DEGLI STUDI DI MILANO

ECOLOGIA DEL GUSTO:

rivalutare i sapori negletti per un'alimentazione più sana e sostenibile

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DeFENS-Department of Food, Environmental and Nutritional Sciences

Rotary Club Milano Manzoni_ 23 marzo 2021

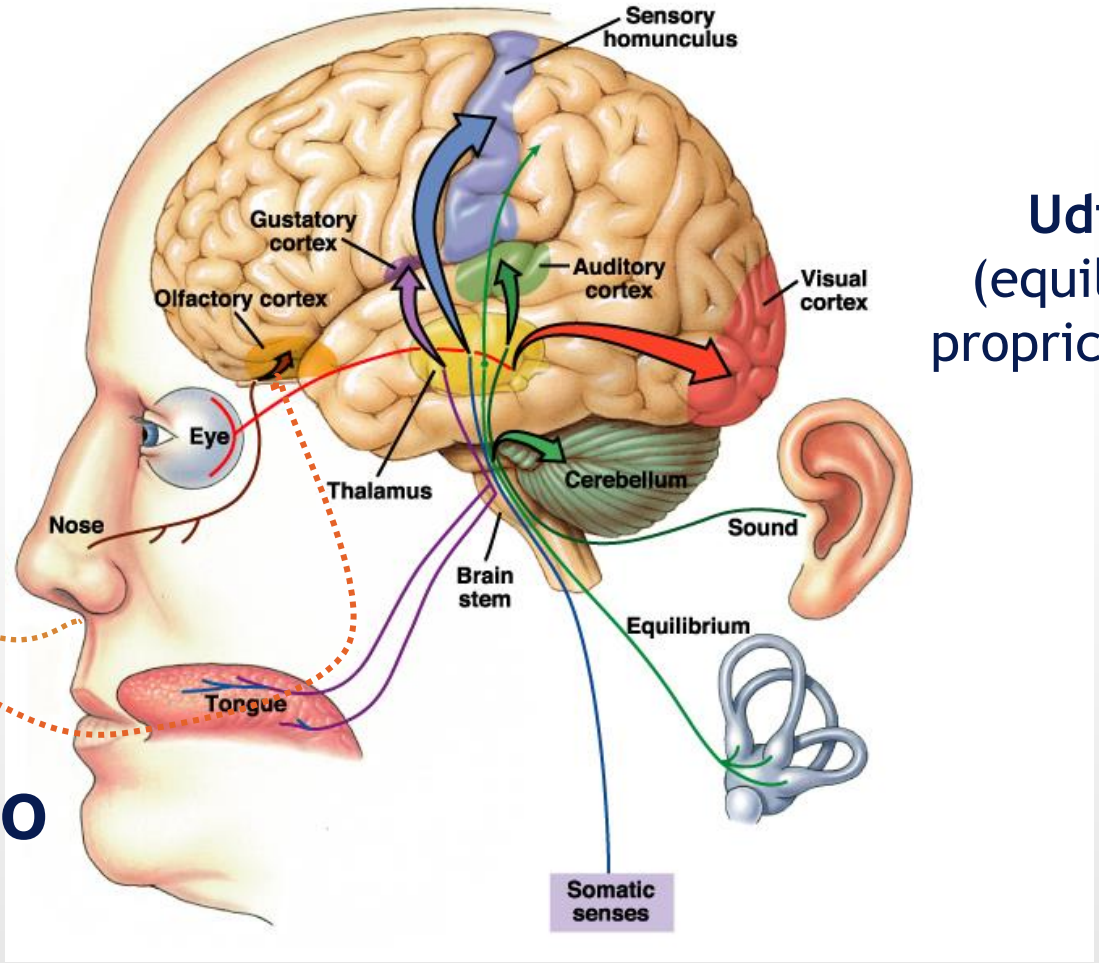
- ✓ I meccanismi del gusto
- ✓ Il problema dei gusti negletti
- ✓ Una nuova ecologia del gusto

I SENSI

Vista

Olfatto (ortonasale e retronasale)

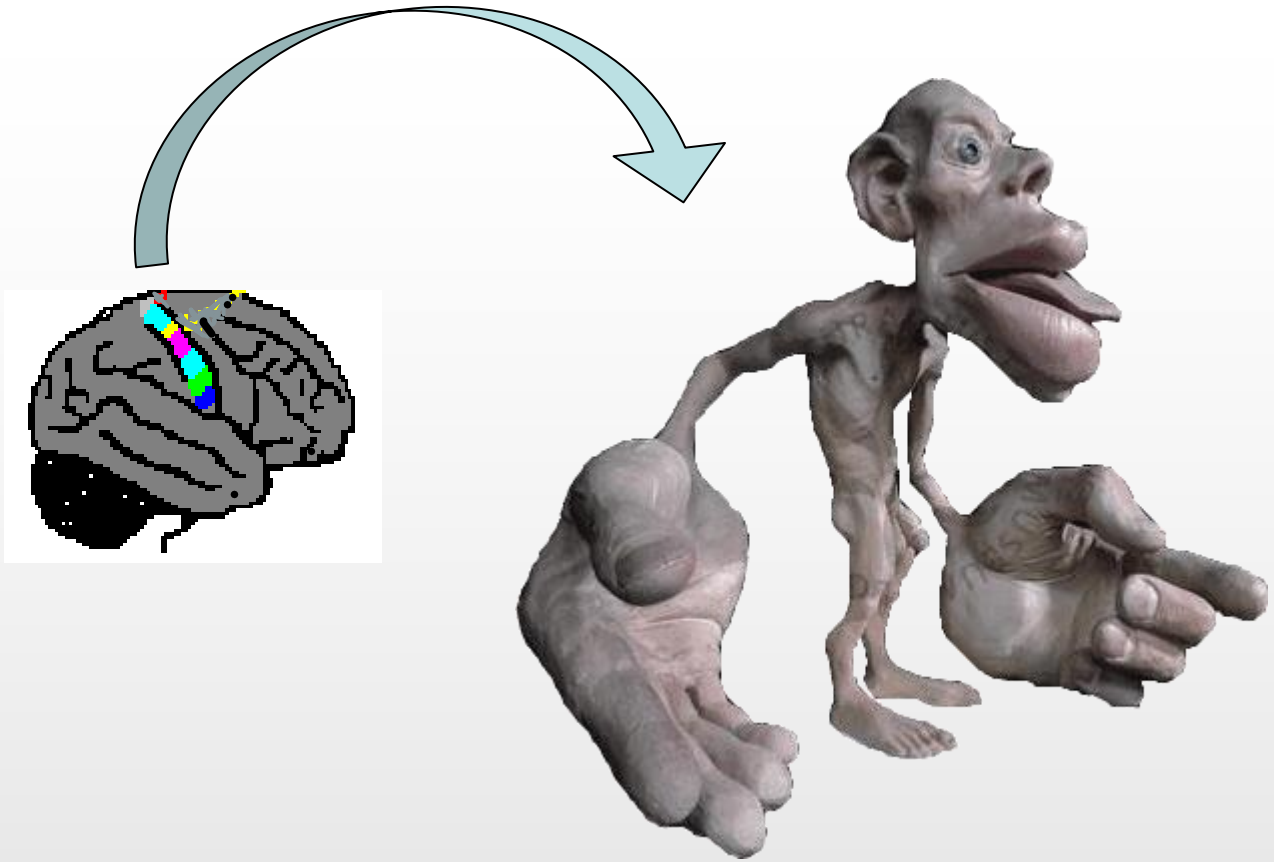
Gusto



Udito, (equilibrio, propricezione)

Sensi somatici (tatto, chemestesi)

L'"HOMUNCULUS" SENSORIALE



I GUSTI «FONDAMENTALI»

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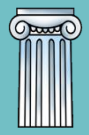
Aristotele (384 a.C.) 7 sapori	AYURVEDA 6 “rasa”	MEDICINA TRADIZIONALE CINESE 5 “wei”	Scienza moderna occidentale 4+1(+2?) sapori
			
Dolce Amaro Acido Salato	Dolce Amaro Acido Salato	Dolce Amaro Acido Salato	Dolce Amaro Acido Salato
Piccante Astringente *Rugoso* (?)	Piccante Astringente	Piccante	Umami (Grasso? Calcio??)

I GUSTI MEDIATI DA RECETTORI

REVIEW ARTICLE *Chemical Society Reviews*, Sept 2017 View Article Online View Journal

Tomáš Pluskal

Jing-Ke Weng

*"Gli esseri umani percepiscono le informazioni sull'ambiente circostante attraverso i **sensi**.*

*Questi messaggi vengono registrati da numerosi sensori specializzati (i **recettori**).*

*In natura esiste una moltitudine di **molecole bioattive** che sono in grado di legarsi a questi recettori."*

I RECETTORI

OUTPUT (cervello)

RECETTORI (papille gustative, mucosa nasale, pelle ecc)

INPUT (stimolo)

Sono dei sensori molecolari in grado di rilevare la presenza di specifiche molecole.

IL MECCANISMO DELLA PERCEZIONE SENSORIALE

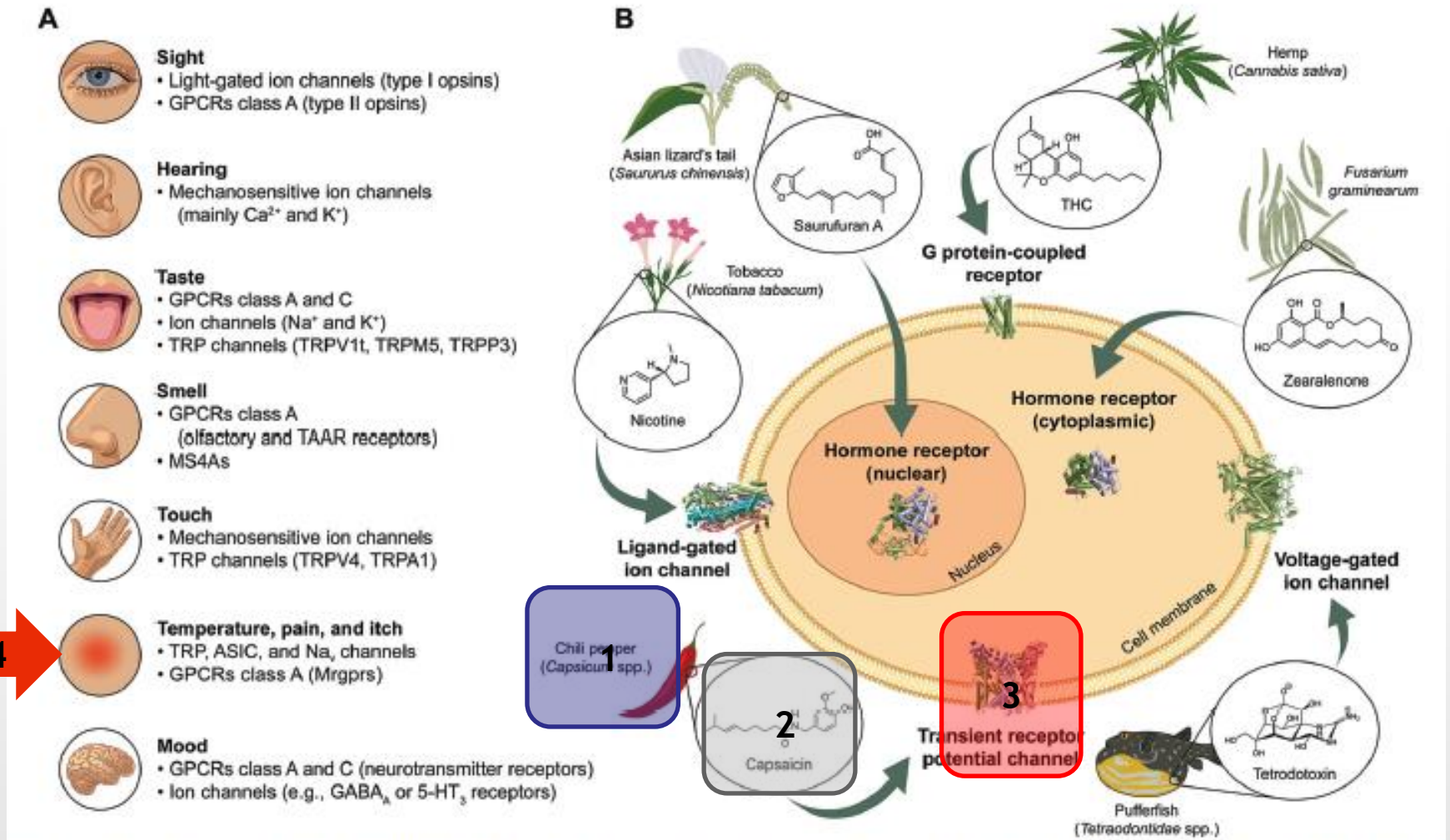
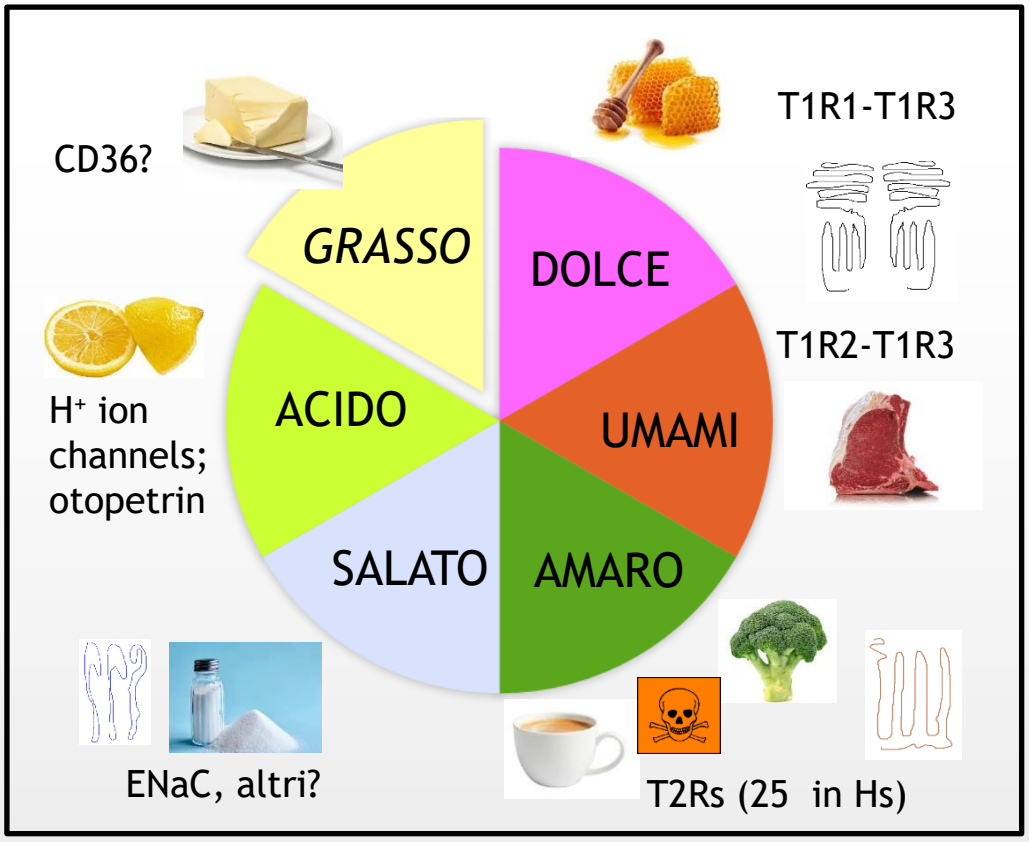


Fig. 1 (A) Human senses and the principal molecular receptors involved in their perception and regulation. (B) Schema of a somatic cell to illustrate the

Pluskal et al, Chemical Society Reviews, 2017

I SEGNALI DEL GUSTO



Individuazione e accettazione dei nutrienti essenziali

Rifiuto di composti potenzialmente tossici

Individuazione di sostanze "farmacologicamente attive"

LE SENSAZIONI «STRANE» (spezie, erbe aromatiche)

IL PROBLEMA DEI GUSTI NEGLETTI

Il problema:

SALUTE:
Obesità, diabete, ipertensione, malattie cardiovascolari, disbiosi microbiche, disturbi alimentari…

La strategia:

AMBIENTE:
Perdita di biodiversità, spreco alimentare

SOCIETA':
Infantilismo alimentare, neofobia, perdita delle tradizioni

I GUSTI NEGLETTI NELLA DIETA OCCIDENTALE

AMARO

Composti amari attivi sui recettori T2Rs con proprietà benefiche (polifenoli, glucosinolati, terpeni…) : *cruciferae, radice di Soncino, bitter mellon…*

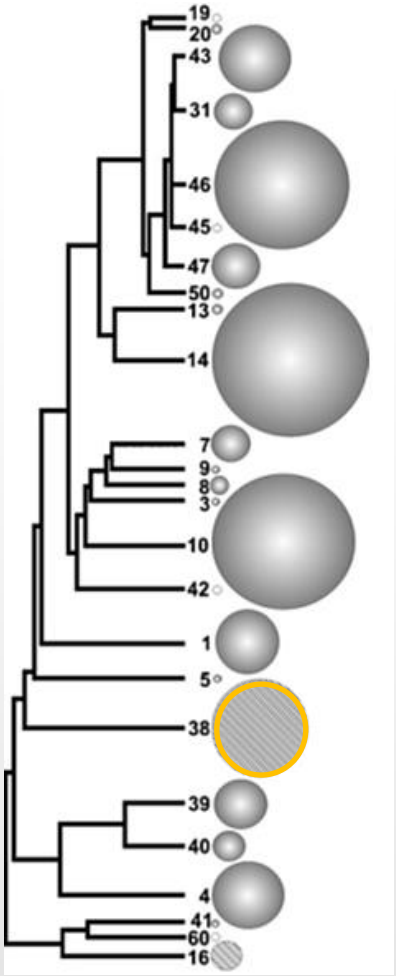
ACIDO

Alimenti acidi fermentati (probiotici, prebiotici): *yogurt, kombucha, kefir, paste acide, injera, kimchi…*

SPEZIATO

Agonisti dei canali ionici TRP con proprietà somatosensoriali (antiinfiammatori, antinocicettivi, antimicrobici..) . *Es. zenzero, curcuma, olio d'oliva…*

IL GUSTO AMARO



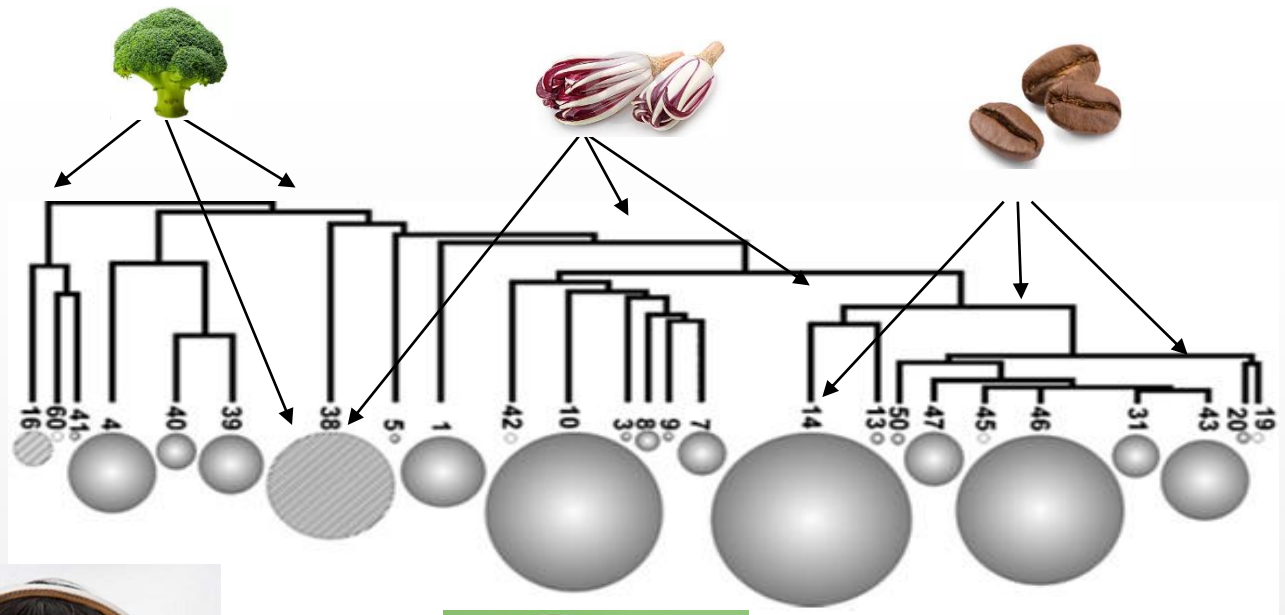
T2Rs

I recettori del gusto amaro
sono **tanti** (25 nell'uomo)

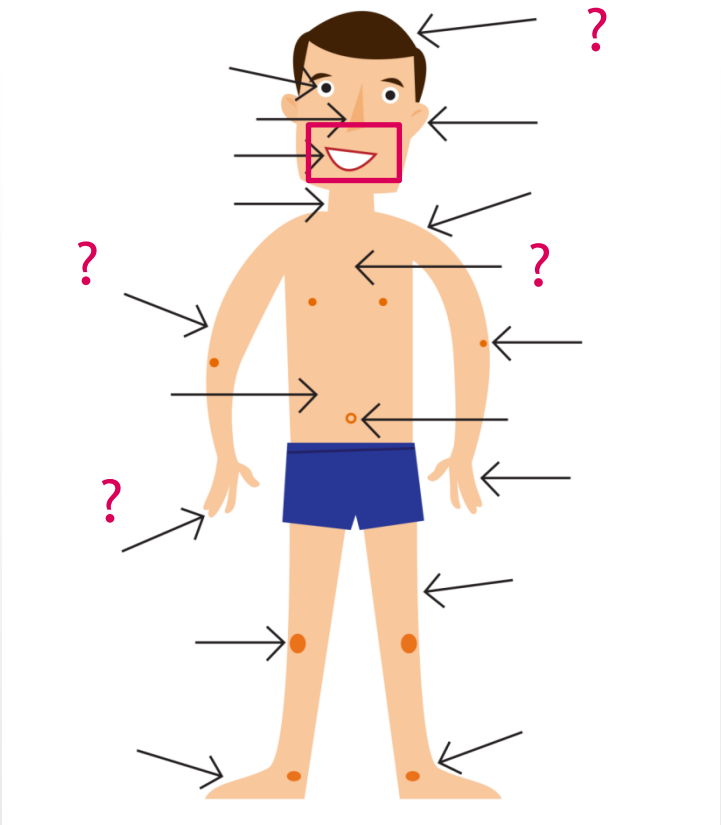
Effettuano il riconoscimento
e la modulazione di migliaia di composti amari diversi

Hanno un'alta **variabilità genetica**

QUINDI ”AMARO“ NON E’ UNA SOLA NOTA, MA UNA *MUSICA* CHE OGNUNO SENTE IN MODO DIVERSO



IL GUSTO AMARO SI SENTE ANCHE “DENTRO”



I recettori T2R sono espressi in diversi organi interni, oltre che nella cavità orale

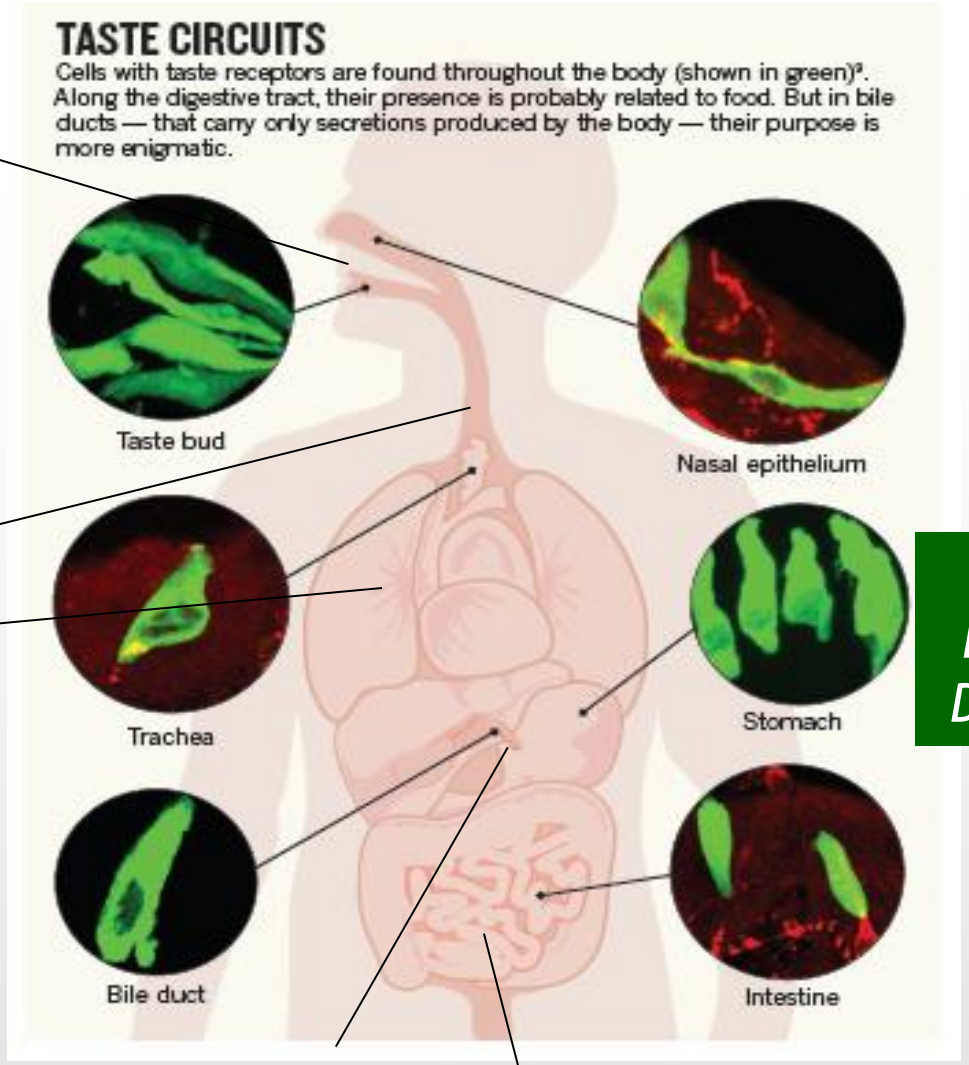
FUNZIONI EXTRA GUSTATIVE

PAPILLE GUSTATIVE, EPITELIO NASALE

GUSTO, AUTO-DIFESA

TRACHEA

BRONCHI



DIGESTIONE, REGOLAZIONE DELL'APPETITO

PANCREAS

COLON

UNA GIUSTA DOSE DI AMARO?

CIBO

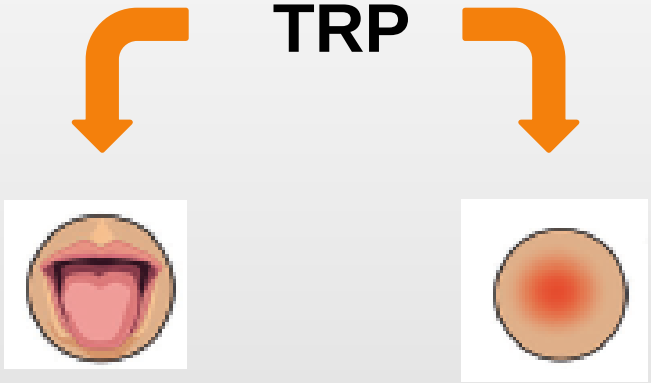
CIBO-MEDICINA

VELENO

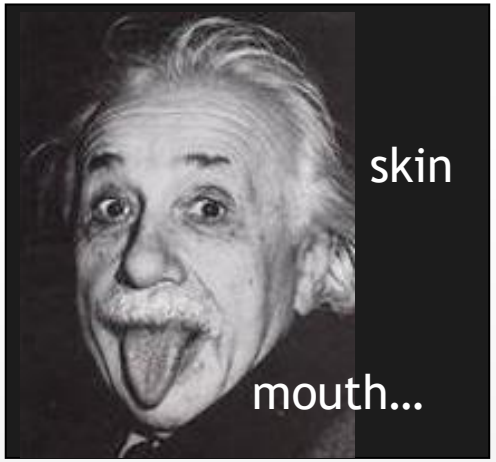
I TRP: “STRANI” MA BUONI




Piccante (hot); rinfrescante (cooling); pungente / lacrimogeno; solletico / formicolìo; anestesia …



TRPs, dove sono?



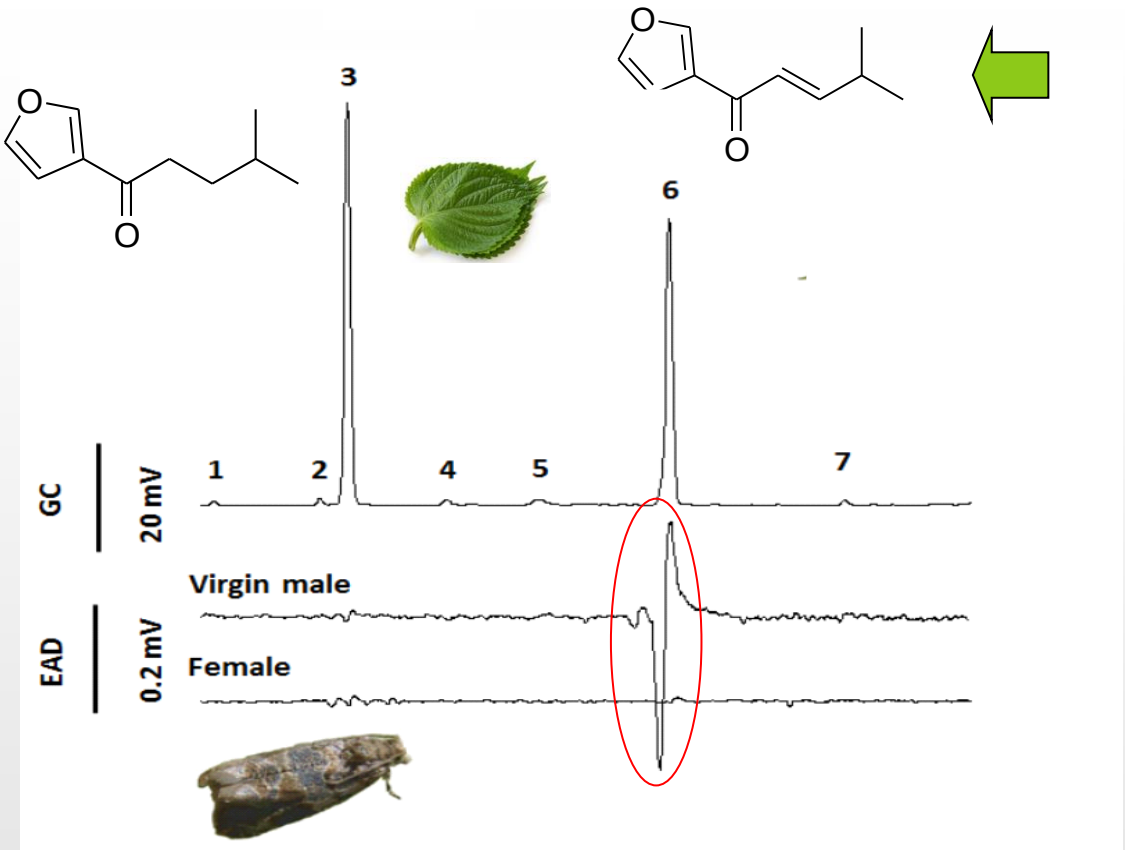
- sono ubiquitari
- sono geneticamente conservati

Applicazioni in *chemical ecology*:

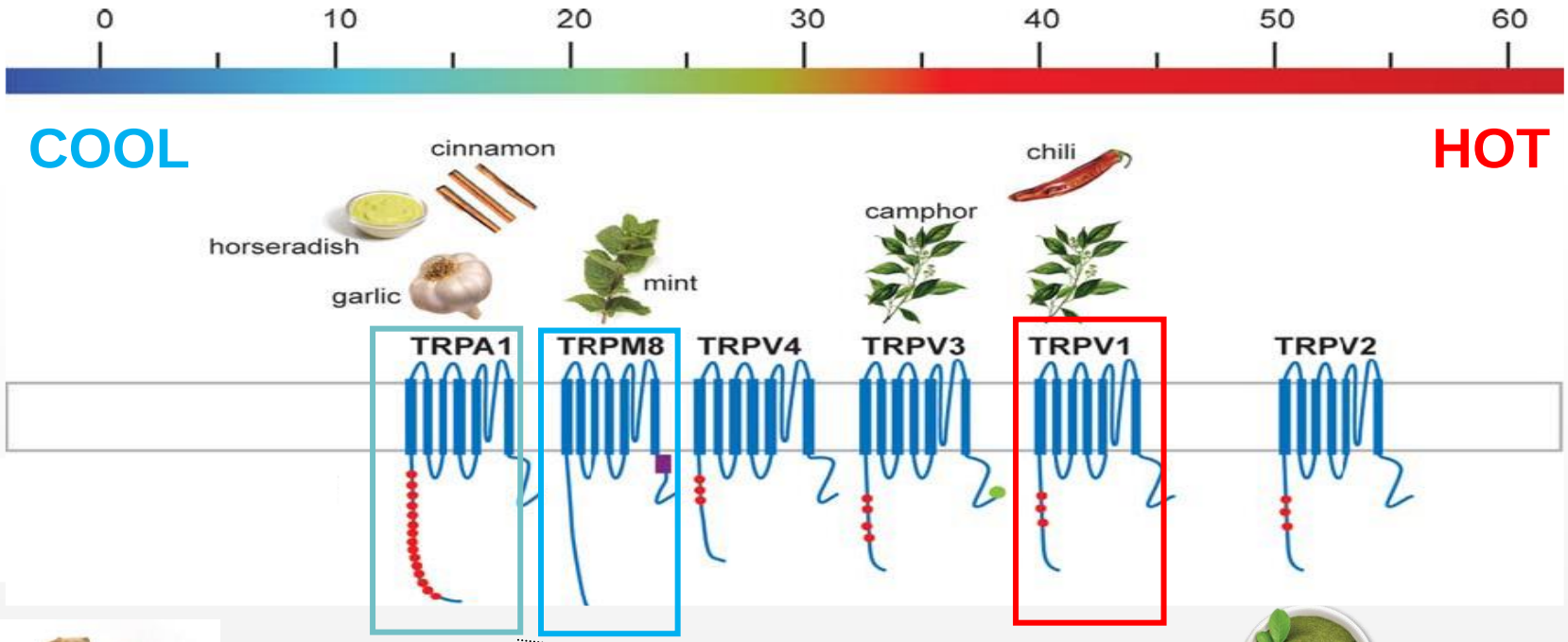
Controllo dell'insetto patogeno Mosca della vite (*Lobesia botrana)* con estratti di PK

GC gascromatografia

Electtroantennografia



SAPORE E… CALORE



zenzero

Moringa oleifera

curcuma

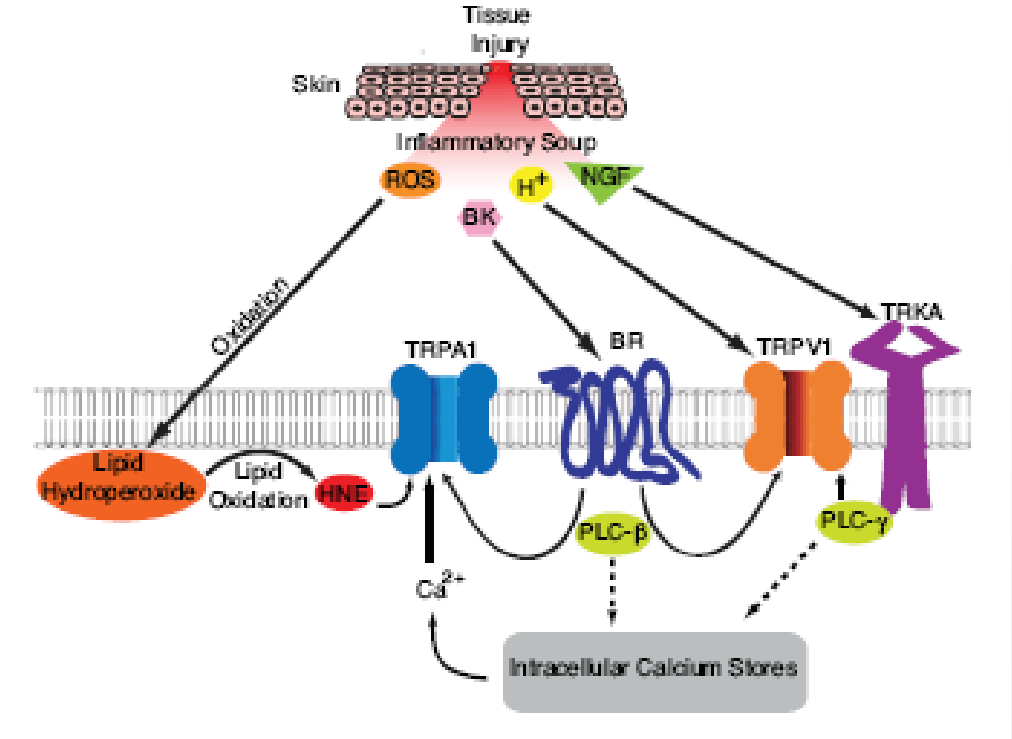
Senape , rucola

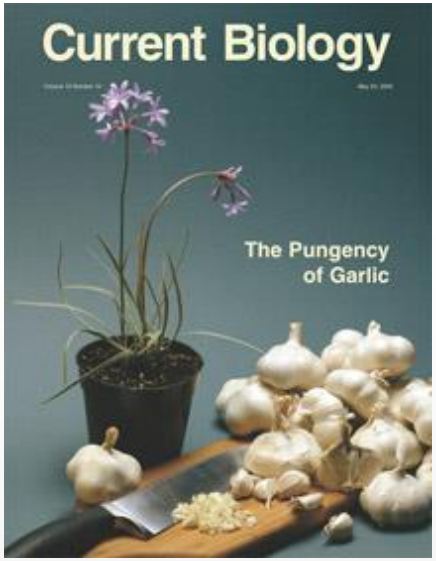
erisimo

broccoli & C

Perilla frutescens

SAPORE E…DOLORE

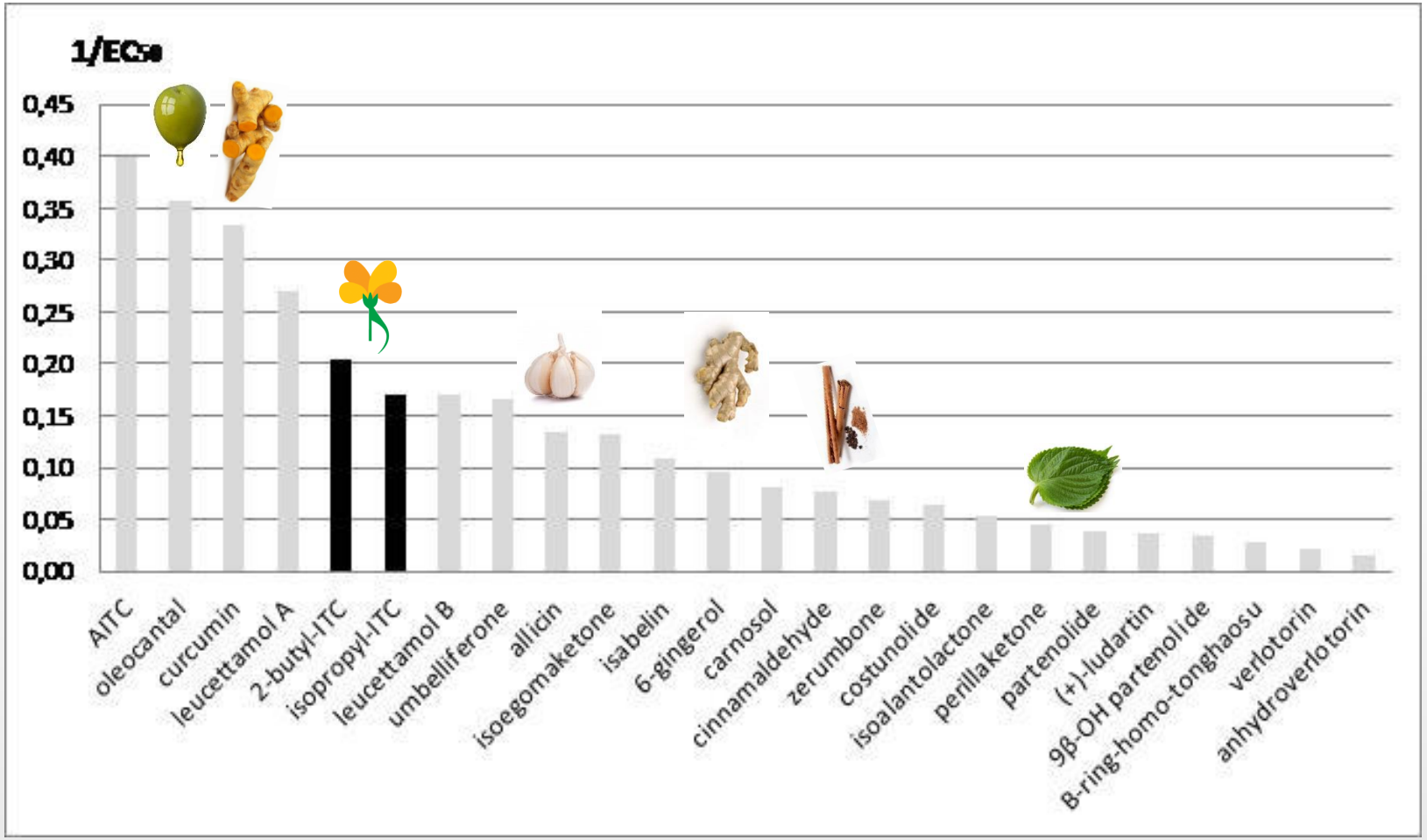




Agonisti di TRPA1 e TRPV1 possono desensibilizzare alla percezione dolorosa generata da fenomeni infiammatori

Trevisani et al. PNAS, 2007

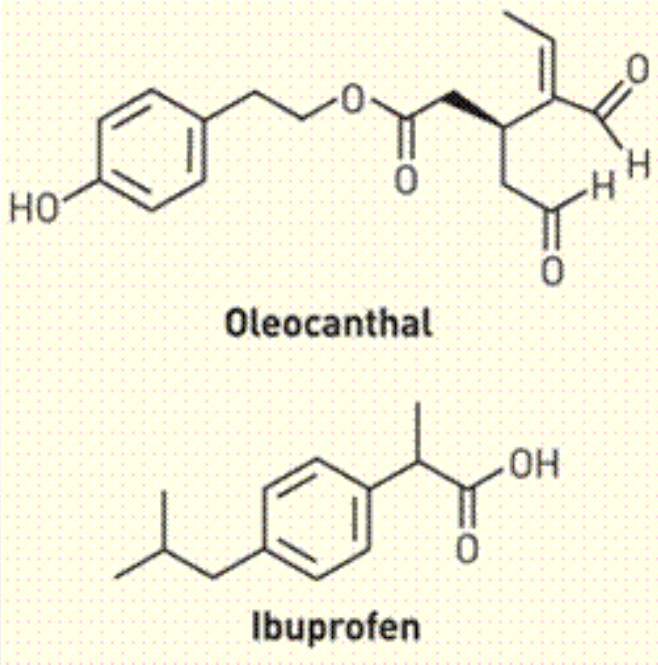
GLI AGONISTI NATURALI DI TRPA1



Attività sul recettore TRPA1 di alcuni composti naturali da piante alimentari

Borgonovo et al. , Molecules, 2019

Applicazioni farmaceutiche:



Beuchamp et al, Nature, 2005

Vol 437|1 September 2005 nature

BRIEF COMMUNICATIONS

Ibuprofen-like activity in extra-virgin olive oil

Enzymes in an inflammation pathway are inhibited by oleocanthal, a component of olive oil.

Newly pressed extra-virgin olive oil contains oleocanthal — a compound whose pungency induces a strong stinging sensation in the throat, not unlike that caused by solutions of the non-steroidal anti-inflammatory drug ibuprofen[1]. We show here that this similar perception seems to be an indicator of a shared pharmacological activity, with oleocanthal acting as a natural anti-inflammatory compound that has a potency and profile strikingly similar to that of ibuprofen. Although structurally dissimilar, both these molecules inhibit the same cyclooxygenase enzymes in the prostaglandin-biosynthesis pathway.

The agent in extra-virgin olive oil responsible for throat irritation is thought to be the dialdehydic form of (−)deacetoxy-ligstroside aglycone[2] (or oleocanthal, with oleo- for olive, -canth- for sting, and -al for aldehyde) (Fig. 1). To confirm this, we isolated (−)oleocanthal from different premium olive oils and measured its intensity as a throat irritant. We found that irritation intensity was positively correlated with oleocanthal concentration. Although this finding indicates that oleocanthal is probably the principal irritating compound in olive oil, it was possible that co-elution of a minor component or a mixture of components could be causing the burning sensation[2]. We therefore completed a *de novo* synthesis of oleocanthal, assigned the absolute stereochemistry (A.B.S. and Q.H., unpublished results), and tested the throat-irritant properties of this synthetic (−)oleocanthal, dissolved in non-irritating corn oil. The effect was comparable to that of premium extra-virgin olive-oil oleocanthal and was also dose-dependent. (For details and for methods, see supplementary information.)

Forty years ago, it was found that the bitterness of certain compounds correlated with their pharmacological activity[3]. On the basis of their shared irritant properties, we therefore tested whether oleocanthal might mimic the pharmacological effects of ibuprofen (Fig. 1), a potent modulator of inflammation and analgesia[4]. Ibuprofen is a non-selective inhibitor of the cyclooxygenase enzymes COX-1 and COX-2, but not of lipoxygenase[4], which catalyse steps in the biochemical inflammation pathways derived from arachidonic acid. We found that, like ibuprofen, both enantiomers of oleocanthal caused dose-dependent inhibition of COX-1 and COX-2 activities but had no effect on lipoxygenase *in vitro* (Table 1).

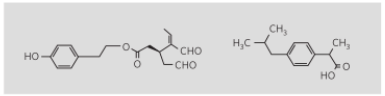


Figure 1 | Structures of (−)oleocanthal (left) and the anti-inflammatory drug ibuprofen (right). How they underpin the similar throat-irritating and pharmacological properties of the two compounds is unclear as yet.

Our findings raise the possibility that long-term consumption of oleocanthal may help to protect against some diseases by virtue of its ibuprofen-like COX-inhibiting activity[5,6]. If 50 g of extra-virgin olive oil containing up to 200 μg per ml oleocanthal is ingested per day[7], of which 60–90% is absorbed[8,9], then this corresponds to an intake of up to 9 mg per day. This dose is relatively low, corresponding to about 10% of the ibuprofen dosage recommended for adult pain relief, but it is known that regular low doses of aspirin, for example, another COX inhibitor, confer cardiovascular health benefits[10]. Ibuprofen is associated with a reduction in the risk of developing some cancers[5] and of platelet aggregation in the blood[11], as well as with the COX-independent secretion of amyloid-β42 peptide in a mouse model of Alzheimer's disease[6]. A Mediterranean diet, which is rich in olive oil, is believed to confer various health benefits, some of which[12] seem to overlap with those attributed to non-steroidal anti-inflammatory drugs.

Our discovery of COX-inhibitory activity in a component of olive oil offers a possible mechanistic explanation for this link.

Table 1 | Selective inhibition of COX enzymes by oleocanthal enantiomers

Agent	Concentration (μM)	COX-1 (%)	COX-2 (%)	15-LO (%)
(−)Oleocanthal	100	83.5 ± 3.5	70.9 ± 8.6	0.4 ± 0.8
	25	56.1 ± 3.2	56.6 ± 9.5	0.0 ± 0.0
	7	24.6 ± 7.3	14.5 ± 2.3	0.0 ± 0.0
(+)Oleocanthal	100	68.0 ± 15.2	69.6 ± 3.9	3.5 ± 5.5
	25	54.5 ± 4.6	41.3 ± 15.9	0.7 ± 1.0
	7	24.6 ± 7.5	6.1 ± 4.2	0.0 ± 0.0
Ibuprofen	25	17.8 ± 2.3	12.7 ± 3.6	0.2 ± 0.3
	7	0.0	1.3	ND
Indomethacin	25	90.1	89.8	0.1 ± 0.9
	7	86.6	66.3	0.5 ± 0.1
NDGA	25	ND	ND	63.1 ± 0.8
	7	ND	ND	52.5 ± 1.1
caffeic acid	25	ND	ND	25.2 ± 2.2
	7	ND	ND	19.8 ± 1.3

Percentage inhibition of cyclooxygenases 1 and 2 (COX-1, COX-2) and 15-lipoxygenase (15-LO) by three different concentrations of oleocanthal and of ibuprofen are presented as mean ± s.e.m. for three independent experiments. ND, not determined. Indomethacin was used as a positive (inhibitory) control in the cyclooxygenase assays and nor-dihydroguaiaretic acid (NDGA) and caffeic acid were used as positive (inhibitory) controls in the lipoxygenase assay. The concentrations for 50% inhibition (IC_{50}; calculated by least-squares regression analysis of inhibition versus concentration) for the natural (−)oleocanthal are 23 μM and 28 μM for COX-1 and COX-2, respectively; IC_{50} values for (+)oleocanthal are 25 μM and 40 μM for COX-1 and COX-2, respectively; IC_{50} values for ibuprofen are 5 μM and 223 μM for COX-1 and COX-2, respectively[13]. (For methods, see supplementary information.)

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Sapori per «uomini» veri?

Diete ricche di composti attivi sui TRP sono comuni in paesi con:

- Condizioni climatiche estreme
- Scarso sviluppo economico e lavoro fisico duro
- Resistenza al dolore fisico come fattore culturale

Un meccanismo alternativo per prevenire/alleviare il dolore?

ALCALOIDI (SNC)

AGONISTI DEI TRP?

SOGLIA DI RESISTENZA AL DOLORE ⬆

AFFATICAMENTO FISICO E MENTALE ⬇

?

UN CIRCOLO VIZIOSO

COME USCIRNE?

CONSUMATORI
o
«SCEGLITORI»?

«Consumers or *eligiters?*»

UNA NUOVA ECOLOGIA DEL GUSTO

GRAZIE
PER L'ATTENZIONE!