# Food, microbiome and cancer: virtuous and dangerous liasons

Luca Vannucci

Laboratory of Immunotherapy Institute of Microbiology Academy of Sciences of the Czech Republic Prague









NOURRIR LA PLANETE ENERGIE POUR LA VIE

#### FEEDING THE PLANET ENERGY FOR LIFE

## MILANO 2015











#### Global Hunger Index scores by severity

- Very alarming (Burundi, Eritrea, Comoros)
- Alarming
- Serious
- Moderate
- Low
- No data
- Industrialized country

Source: German Welthungerhilfe (GHI 2013)© DW

http://www.dw.com/en/stopping-starvation-everyone-can-do-something/a-17155293

805 million chronically undernourished people in the world (~9% of world population)

The Sydney Morning Herald 20,000 die each day



© DW

#### European Development Fund (EDF)

The total financial resources of EU for the 11th EDF amount to €30.5 billion for the period 2014-2020 (around €5 billion/year)

#### FAO and EU Partnership



Food and Agriculture Organization of the United Nations

http://www.fao.org/europeanunion/funding/eufund/en/

According to the European Pet Food Association **pet food** sales are **5 million tonnes** a year to the value of **€ 8.5 billion**.

#### In 2005 the pet food market in Western Europe was € 6.4 billion.

The economic importance of companion animals. FECAVA (The Federation of European Companion Animal Veterinary Associations) February 2007 www.fecava.org





http://www.statista.com/statistics/343105/sales-value-pet-food-and-accessories-sales-by-european-country/

Chronic illnesses represent high costs for the society Therefore, cancer is also a big economical problem

USA

# total expenditure for healthof \$2.8 trillion/year

The 13.3 million new cases of cancer in 2010 were estimated to cost US\$ 290 billion (~10% of total healthcare budget)

**IMPORTANCE OF REDUCTION OF RISK AND EARLY DIAGNOSIS** 

### **Obesity:** An Epidemic among Black kids







DIFFERENT CONTINENTS





OPPOSITE CONDITIONS SIMILAR OUTCOME

DEATH



Metabolic disorders dysproteinaemia, infections cardiovascular disorders

Cardiovascular and respiratory illnesses,

cancer

#### Estimated Calorie Requirements (in Kilocalories) for Each Gender and Age Group at Three Levels of Physical Activity<sup>a</sup>

	Activity Levelsed				
Gender	Age (years)	Sedentary*	Moderately Active	Active	
Child	2–3	1,000	1,000-1,400 <sup>e</sup>	1,000-1,400e	
Female	4-8	1,200	1,400-1,600	1,400-1,800	
	9-13	1,600	1,600-2,000	1,800-2,200	
	14-18	1,800	2,000	2,400	
	19-30	2,000	2,000-2,200	2,400	
	31-50	1,800	2,000	2,200	
	51+	1,600	1,800	2,000-2,200	
Male	4-8	1,400	1,400-1,600	1,600-2,000	
	9–13	1,800	1,800-2,200	2,000-2,600	
	14-18	2,200	2,400-2,800	2,800-3,200	
	19-30	2,400	2,600-2,800	3,000	
	31-50	2,200	2,400-2,600	2,800-3,000	
	51+	2,000	2,200-2,400	2,400-2,800	

About 2100-2500 Kcal adult in active life

Body weight should be around the number of cm of height exceeding 1 m (e.g. 1.75 m, around 75 kg).

Exercize can increase the muscular mass increasing the weight but attention to the effects of artificially pumping the muscles by supplementation with various anabolizing products, having side effects on liver, circulation and hormonal balance.

Source: HHS/USDA Dietary Guidelines for Americans, 2005

		2000 Calories	1200 Calories	800 Calories
Nutrient	Unit of Measure	Daily Values	Daily Values	Daily Values
Total Fat	grams (g)	65	39	26
Saturated fatty acids	grams (g)	20	12	8
Cholesterol	milligrams (mg)	300	180	120
Sodium	milligrams (mg)	2400	1440	960
Potassium	milligrams (mg)	3500	2100	1400
Total carbohydrate	grams (g)	300	180	120
Fiber	grams (g)	25	15	10
Protein	grams (g)	50	30	20

## TO FIT OR TOO FAT ? IS THAT THE QUESTION?





## alimentation







## WESTERN DIE

220

even right in front of you





eatrastra



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MEDITERRANEAN DIET

LEAN MEAT 2 portions a week FISH 3-5 portions a week LEGUMES 2-4 portions a week

MILK, YOGHURT AND CHEESE 2-4 portions a day

> VEGETABLES 2 or more rations a day FRUITS 3 or more rations a day OLIVE OIL 3-6 rations a day

> > CEREALS, BREAD, TUBERS, POTATOES 4-6 rations a day



820 Calories McDonalds Double Cheeseburger with a Medium French Fry



820 Calories Burger King Triple Stacker with a Strawberry Sundae



850 Calories Subway Roast Beef Footlong with Sun Chips

©www.botanical-online.com

## WESTERN FATTY PEOPLE

#### In USA

- more than one-third (34.9% or 78.6 million) of adults are obese.
- approximately 17% (or 12.7 million) of children and adolescents aged
  2—19 years are obese

[JAMA. 2014;311(8):806-814]

In EUROPE



- over 50% of both men and women in are overweight
- roughly 23% of women and 20% of men are obese
- 19.3-49.0% of boys and 18.4-42.5% of girls were overweight (variability with nationality, highest in UK)
- The prevalence of obesity ranged from 6.0 to 26.6% among boys and from 4.6 to 17.3% among girls

[WHO Europe]



American Cancer Society study among 48,500 men and 56,343 women age 50 and older.

Research shows the **waistline** good reference for mortality and cancer risk. If > 94cm for men and >80cm for women the risk for some types of cancer increases, while with a waistline of >102cm for men and >88cm for women risk greatly increases. Similarly the mortality risk increases.

Leitzmann MF, Moore SC, Koster A, Harris TB, Park Y, Hollenbeck A, Schatzkin A. Waist circumference as compared with body-mass index in predicting mortality from specific causes. PLoS One. 2011 Apr 26;6(4):e18582

Yang CY, Peng CY, Liu YC, Chen WZ, Chiou WK. Surface anthropometric indices in obesity-related metabolic diseases and cancers. Chang Gung Med J. 2011 Jan-Feb;34(1):1-22







ALMOST 30 min daily of physical activity (walking, running, biking, swimming,...) can reduce cancer risk, associated to a balanced diet



## SOMETHING MORE.....

## food additives, food processing, and organic foods

#### Food additives and contaminants

Substances to prolong shelf and storage life and to enhance color, flavor, and texture of foods

Must be admitted by Ministerial control, after in vivo lab tests on animals Additives are **usually present in very small quantities in food Sometimes they are nutrients** (for example, **vitamins C** – ascorbic acid, ascorbate and E are sometimes added to food products as a preservative)

Other compounds find their way into the food supply through agricultural use, animal farming, or food processing, even if their use is not directly intended for human consumption:

- <u>hormones or antibiotics used in animal farming</u>,
- small amounts of **pesticides and herbicides in plant-based foods**,
- compounds such as **bisphenol A (BPA) or phthalates from packaging**.
- Some of these compounds are <u>not known to directly cause cancer</u>, but they may influence cancer risk in other ways – for example, by acting as hormonelike substances in the body.
- Unintended contamination of food may also result in exposure to chemicals that are a cause of concern and may be related to cancer risk, like
- heavy metals such as cadmium or mercury (e.g. in fish, or they may enter through contamination or their natural presence in soil or water)

#### **Food processing**

**Food processing may also alter foods** in ways that might affect cancer risk.

- Refining of grains greatly **lowers the amount of fiber** useful as prebiotics for reducing cancer risk.
- The processing of meat, by adding preservatives :
- salt or sodium nitrite to prevent the growth of germs,
- smoking the meat to preserve or enhance color and flavor
- these manipulations may add compounds that might increase the potential of these foods to cause cancer (e.g. nitrites in lunch meats, hams, hot dogs, and other processed meats)





• eating large amounts of processed meats helps to increase risk of colorectal cancer.

Processes like **freezing** and **canning vegetables and fruits**, **can preserve vitamins and other components that may decrease cancer risk**.

**Cooking or heat-treating (such as when canning) vegetables,** breaking down the plant cell walls, **allow the helpful compounds in the foods to be easily digested**. However, **heat-sensitive vitamins,** such as vitamin C and some B vitamins **may lower**.





Cooking meat at the high temperatures (to grill as well as broil and fry)creates heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs) that are carcinogenic products Pickled, smoked, barbecued and processed meats (e.g., bacon, ham, sausage, hot dogs, salami, bologna, luncheon meats, corned beef, etc.) seem to cause the most health problems.

It's the intake of these meats that are more related to cancer risk than total red meat intake alone. Other dense protein foods (milk, eggs, legumes, and organ meats) have very little or no HCA content naturally or when cooked.

Research in the Journal of Agriculture and Food Chemistry showed that **marinating red meat in beer or wine for two hours significantly reduced HCAs**. The antioxidants in these marinades may block HCAs from forming HCAs. Similarly, a Kansas State University study found that rubbing **rosemary** (high level of antioxidants) onto meats before grilling cut HCA levels by up to 100 percent. Herbs including **basil, mint, sage** and **oregano** may have similar effects. **Acrylamide** is another one of the toxic Mallard reaction\* end products, forming when **asparagine reacts with naturally occurring sugars in high carbohydrate/low protein foods subject** to high cooking temperatures. Reactions start at 248 degrees F (**120 degrees** C).

The **higher the cooking temperature** and the **longer the cooking duration**, **the more acrylamide** (genotoxic, mutagenetic)

Most foods that contain acrylamide are cooked commercially and contain the acrylamide when purchased. Think French fries, potato chips, breakfast cereals, crackers, pretzels, coffee, pastries, etc.



\*Maillard reaction, which occurs when sugars and proteins in the food react together with heat and creates advanced glycation end products (AGEs), also known as glycotoxins



'I'm trying to drink six cups, but it's very difficult to get beyond the third one...'

## Six cups of coffee a day 'can slash prostate cancer risk'

By <u>Fiona Macrae for the Daily Mail</u> Updated: 16:45 GMT, 18 May 2011 <u>15</u> <u>View</u> <u>comments</u>

Drinking cup after cup of coffee could more than halve the odds of developing a deadly prostate tumour, research suggests.

A 20-year study of almost 50,000 men found those who drank at least six cups a day were 20 per cent less likely to get prostate cancer than those who never touched the stuff.

Strikingly, they were 60 per cent less likely than the non-coffee drinkers to die of the disease.

Read more:

http://www.dailymail.co.uk/health/article-1388200/Coffee-cuts-prostate-cancer-risk-drink-6cups-day.html#ixzz3gMFH1U00 Follow us: @MailOnline on Twitter | DailyMail on Facebook **1,3-Butadiene, benzene, acrolein, formaldehyde**, and other related compounds were qualitatively and quantitatively detected, with **emissions tending to be highest for unrefined Chinese rapeseed oil** and **lowest for peanut oil and olive oil**.

A Chinese study put in relation the use of less refined oils in wok cooking, the air pollution produced and lung cancer.

Shields PG, Xu GX, Blot WJ, Fraumeni JF Jr, Trivers GE, Pellizzari ED, Qu YH, Gao YT, Harris CC. Mutagens from heated Chinese and U.S. cooking oils. J Natl Cancer Inst. 1995 Jun 7;87(11):836-41

OLIVE OIL has antioxidants, which belong to two categories, lipophilic antioxidants (mainly tocopherols), more soluble in oil, and hydrophilic antioxidants (mainly acids, phenolic alcohols and compounds), more soluble in water. Tocopherols are destroyed or inactivated at 180 °C, while biphenols and polyphenols are more resistant and oil protective at higher temperatures. The smoke point refers to the temperature at which an oil begins to emit toxic, mutagenic, and carcinogenic smokes, which contain aldehydes, such as acrolein

#### ALCOHOL

**Damage to body tissues**: irritant, especially in the mouth and throat. Cell damage, influence on DNA repair and mutations.

In the colon and rectum, bacteria can convert alcohol into large amounts of acetaldehyde, a chemical that has been shown to cause cancer in lab animals.

Alcohol and its byproducts can also damage the liver, leading to inflammation and scarring, DNA instability

Effects on other harmful chemicals: Alcohol can act as a solvent, helping other harmful chemicals, such as those in tobacco smoke, enter the cells lining the upper digestive tract more easily. This might explain why the combination of smoking and drinking is much more likely to cause cancers in the mouth or throat or esophagus than either smoking or drinking alone.

**Lower levels of folate or other nutrients**: Folate is a vitamin. Alcohol use can lower the body's ability to absorb folate from foods. Low folate levels may play a role in the **risk of breast and colorectal cancers.** 

Effects on estrogen or other hormones: Alcohol can raise body levels of estrogen. This could affect a woman's risk of breast cancer.

**Effects on body weight: Too much alcohol can add extra calories to the diet**, Being overweight or obese is known to increase the risks of many types of cancer.





A sugar substitute (artificial sweetener) is a food additive that duplicates the effect of sugar in taste, but usually has less food energy. Besides its benefits, animal studies have convincingly proven that artificial sweeteners cause weight gain, brain tumors, bladder cancer and many other health hazards. Some kind of health related side effects

including carcinogenicity are also noted in humans.

Artificial sugar substitutes	Potency [Times sweeter than sucrose]	Approved by FDA	Acceptable daily intake (ADI) (mg/kg of body weight/day)
Acesulfame potassium	200	1988	15
Alitame	2000	Pending approval	196
Aspartame	160-200	1981	40
Salt of aspartame- acesulfame	350	25	
Cyclamate	30	Banned 1969, pending re-approval	1840
Dulcin	250	Banned 1950	
Glucin	300	87	123
Neohesperidin dihydrochalcone	1500	27	121
Neotame	8000	2002	18
Saccharin	300	1958	5
Sucralose	600	1998	Permitted for use under interim regulation

Tandel KR. Sugar substitutes: Health controversy over perceived benefits. J Pharmacol Pharmacother. 2011 Oct;2(4):236-43

#### **Organic foods**

Concern about the possible effects of food additives on health, including cancer, is one reason that many people are now interested in organic foods. Organic foods are often promoted as an alternative to foods grown with conventional methods that use chemical pesticides and herbicides, hormones, or antibiotics. These compounds cannot be used for foods labeled as "organic." Organic foods, as defined by the US Department of Agriculture (USDA), also exclude genetically modified foods or foods that have been irradiated.

Whether organic foods carry a lower risk of cancer because they are less likely to be contaminated by compounds that might cause cancer is largely unknown.

Several studies have looked at the nutrient content of organic versus conventionally grown fruits or vegetables, and while some studies suggest a higher nutrient content, others suggest no difference. It is not known if the nutritional differences that have been reported would result in health benefits such as a reduced cancer risk.

Vegetables, fruits, and whole grains should form the central part of a person's diet, regardless of whether they are grown conventionally or organically.











## CANCER

## MICROBIOTA

AND

## IMMUNITY



Age-standardised death rates from Malignant neoplasms by country (per 100 000 inhabitants).

Jemal A, Siegel R, Ward E et al. (2008). "Cancer statistics, 2008". *CA Cancer J Clin* **58** (2): 71–96.



205-230 /100 000 inhab.

230-255/100 000 inhab.





## **GENETIC FACTORS**





## ENVIROMNENTAL FACTORS



## **EPIGENETIC FACTORS**





INITIATION

#### PROMOTION

#### PROGRESSION









#### COLORECTAL CANCER PROGRESSION IN RAT EXPERIMENTAL MODEL OF AOM-BILE INDUCED CARCINOGENESIS (Vannucci et al, 1994)







#### Tumor development in GF vs CV AVN rats



**Total tumor number/group** 

% of tumor bearing rats/group

Mean tumor dimensions/group

## Colorectal carcinoma development

Environmental (e.g. alimentation) and local carcinogens and CO-

carcinogens/promo

**ters**(e.g. gut flora metabolites, nitrosamines, chenodeoxycholic acid)

### Specific gut and tumor microenvironment

(e.g. cytokines from chronic inflammatory pathologies, type of microbiota)



"Our menu is divided into three sections: Cancer causing foods, artery clogging foods, and foods that are being boycotted for political or environmental reasons."

