

New data on the composition of 100% orange juice reveals wide array of nutrients and bioactives

It is well-accepted that fruits contain many different nutrients and plant compounds (often called bioactives), but what about fruit juices?

Citrus fruits, and their juices, are recognised as important sources of vitamin C, folate and potassium. There is less awareness that they are also rich in polyphenols; specifically, the flavanones hesperidin, naringin and narirutin. Apples, and their juices, provide other groups of polyphenols, such as catechins, quercetin and rutin.

In planta, polyphenols protect against stresses e.g. UV light, deter attacks from pests, and provide colour to attract pollinators.¹ In humans, many of these same polyphenols have a role in maintenance of health, according to observational and intervention studies.

Despite this scientific knowledge, a 2017 IPSOS survey² in 2,099 European healthcare professionals revealed misconceptions about the nutritional value of

fruit juices and the impact of processing on the vitamin content. Furthermore, there was confusion about the purity of packaged orange juice, especially with respect to sugars and preservatives (which contrary to some beliefs are not added to 100% juices).

Only 37% of all healthcare professionals fully agreed that 100% orange juice is just that: 100% fruit juice. Dietitians and nutritionists had a greater degree of knowledge compared with general practitioners (GPs) and paediatricians, perhaps reflecting that medics receive less than 24 hours of training in nutrition during their years of study.³ As populations gradually shift from a cure to care model, focussing more on disease prevention rather than treatment, it becomes increasingly important to understand the beneficial role that nutrition can play. Therefore, this article will summarise five facts on the nutritional composition of 100% orange juice and why this is of relevance to health and wellbeing.

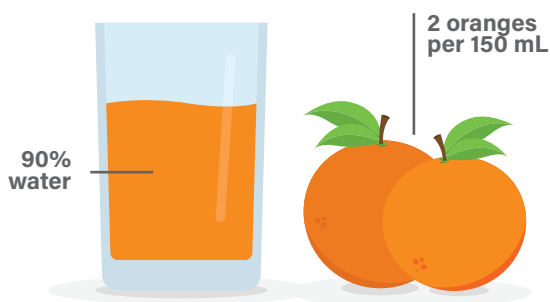
New data on the composition of 100% orange juice

All fruit juice sold in Europe is regularly audited for safety and composition during the production process by a not-for-profit body called SGF International.⁴ Data collected by trained auditors on hundreds of samples of 100% orange juice prior to bottling reveal the wide array of nutrients and bioactives in a serving. This confirms that 100% orange juice is not simply a “sugary beverage” as has been suggested in the past.

On average, a typical small glass (150 mL) of 100% orange juice provides 67.5 mg of vitamin C, which is more than 80% of the Nutrient Reference Value (NRV), the recommended daily amount for maintaining general health (Figure 1). A serving also provides 16% of the NRV for folate and 13% of the NRV for potassium.

	100 mL	150 mL	200 mL
Energy (kcal)	41	62	82
Total sugars (g)	9	14	18
Vitamin C (mg)	45	67.5	90
Potassium (mg)	176	264	352
Folate (mcg)	21.5	32.3	43
Total carotenoids (mg)	0.7	1.1	1.4
Hesperidin (mg)	52	78	104
Pectins (mg)	33.4	50.1	66.8

Figure 1: What's in a glass of 100% OJ? Data from SGF International (2018) and other sources. 1-2 medium-sized oranges per glass of 100% OJ based on published calculations from Tetra Pak.⁵



Fact 1: “100% juice” means nothing artificial is added

In the IPSOS survey, there were strong misconceptions about the purity of orange juice. Worryingly, 31% of healthcare professionals were not convinced

that “100% orange juice” on a label meant that the product was 100% juice, while 28% believed wrongly that colourings were added and 47% thought wrongly that preservatives were used. In fact, a European directive⁶ strictly controls the production of 100% fruit juice so that nothing artificial can be added, and nothing can be removed. This includes sugar, preservatives, colourings, stabilisers, flavourings and even water. Therefore, when a label states “100% orange juice”, only pure orange juice made from whole oranges will be inside the package. The vitamins, minerals, water content and natural sugars will reflect what was in the original fruits used to make the juice.

Fact 2: 100% orange juice is rich in polyphenols

100% orange juice is known for its vitamin C content but there is little awareness that it is one of the richest sources of hesperidin, a polyphenol from the flavanone sub-class. Indeed, in the IPSOS survey, two thirds of healthcare professionals were unaware that 100% fruit juices contained polyphenols. Studies show that hesperidin exhibits anti-inflammatory⁷ characteristics, and can impact positively on human microvascular function (elasticity and tone of blood vessels).⁸ Average citrus juice intakes in Europe are generally low (< 40 mL/day), as are hesperidin intakes estimated to be 25 mg/day in the UK¹ and 7.1 mg/day in Denmark.⁹

100% orange juice delivers more hesperidin than vitamin C according to data from SGF¹⁰ which show that 100 mL typically provides 52 mg of hesperidin, or 78 mg per typical serving (150 mL). The range across samples from different producers is wide at 11 to 116 mg (Figure 2). The reasons for this relate to a combination of factors: natural variability due to differences in weather, soils and the cultivated orange varieties, dejuicing methods, and the pulp content of the juices. As orange pulp is particularly rich in hesperidin, there are greater amounts in pulprich juices. The SGF figures are supported by research by the Universidade Federal da Bahia, Brazil.¹¹

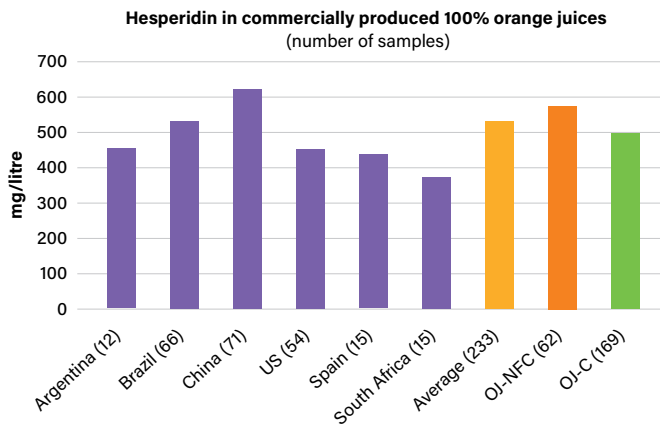


Figure 2: Data from SGF (2018) representing mean hesperidin content from each country of origin including sample sizes; OJ-NFC, orange juice not from concentrate; OJ-C, orange juice from concentrate from a separate SGF analysis.

In human diets, hesperidin is poorly absorbed intact and requires the action of gut bacteria to convert it into metabolites, e.g. hesperetin (a metabolite of hesperidin). The metabolites are then available for absorption.¹² Levels of hesperidin metabolites peak in plasma approximately 5 hours post-ingestion.¹³

Fact 3: pasteurisation and storage of 100% orange juice do not destroy the nutrients

There is often confusion about the production process of 100% orange juice and its nutrient content during manufacture and storage. Commercially made juices can be heat-treated (pasteurised) or pressure-treated in order to produce microbiologically safe products.

Vitamin C is prone to degradation by oxygen, and this unfavourable reaction is accelerated by heat. This occurs whether the juices are made at home or in commercial premises. However, as far as possible, producers try to limit oxygen exposure and input to the juices to minimise the degradation of vitamin C during pasteurisation. Research from AMC Juices & AMC Innova¹⁴ suggests that levels of vitamin C in 100% orange juice remain well above the legal cut-off of 12 mg/100 mL for a “rich in” claim¹⁵, even after refrigeration for 56 days (Figure 3). In other studies, 100% orange juice was found to contain 20 mg of vitamin C per 100 mL for up to 10 months when stored at 4 °C¹⁶, while the same was true for 100% orange juice stored at ambient temperatures (18-20 °C) for up to 6 months.¹⁷ Both of these levels are above that required by law for a “source of” claim.

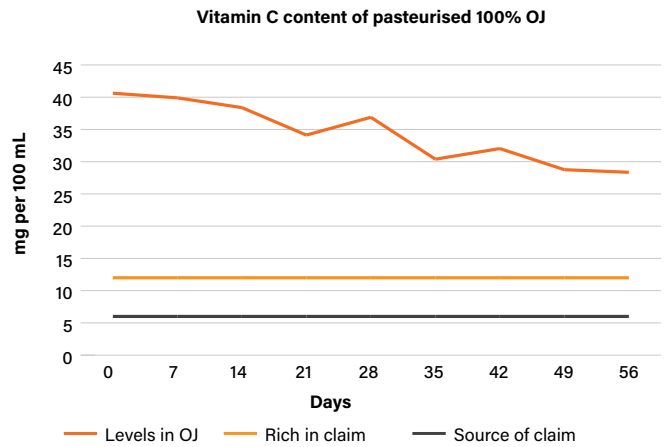


Figure 3: Data from AMC (2017) tracking the content of vitamin C in pasteurised 100% OJ (Spain).

Unlike vitamin C, hesperidin is far less susceptible to degradation by oxygen or temperature. At 4 °C, after 6 months, loss of hesperidin is 2%.¹⁸ At ambient temperature (18 °C), hesperidin loss is 9% after 6 months (mainly seen during the first 2 months).

Although whole oranges contain 2.4 times more hesperidin than 100% orange juice, humans absorb an identical amount of hesperetin (a metabolite of hesperidin) irrespective of consuming juice or whole oranges. This indicates their nutritional equivalence in terms of hesperidin. The poorer uptake of hesperidin from whole fruit is most likely due to the limited solubility of hesperidin in digestive fluids, as well as the greater pectin content of whole fruit which inhibits hesperetin absorption.¹⁹ In terms of packaged versus freshly squeezed orange juice, around three times more hesperetin appears in plasma after packaged 100% orange juice, which has a richer hesperidin content due to the more efficient juicing process.²⁰

Fact 4: 100% orange juice contains three nutrients that are proven to support normal health

100% orange juice contains enough vitamin C, folate and potassium ($\geq 7.5\%$ NRV per 100 g) to allow nutrition claims to be made on pack and in marketing information to consumers. Each of these nutrients has a set of authorised health claims in Europe²¹ as summarised below:

Vitamin C	Folate	Potassium
Increases iron absorption	Helps normal psychological function	Supports the maintenance of normal blood pressure
Helps the immune system to work normally	Helps the immune system to work normally	Helps muscles to work normally
Helps protect cells from oxidative stress	Has a role in the process of cell division	Contributes to normal functioning of the nervous system
Helps reduce tiredness and fatigue	Helps reduce tiredness and fatigue	

Fact 5: 100% orange juice made from concentrate has equivalent levels of nutrients and bioactives

100% orange juice made in a commercial setting can be freshly squeezed and briefly pasteurised to ensure food safety, or concentrated by water evaporation under vacuum in order to be transported and reconstituted nearer to the point of sale.

Contrary to some beliefs, 100% orange juice made from concentrate does not contain added sugars, preservatives or nutrient fortification and is reconstituted as per European regulations. 100% orange juice made from concentrate is a useful product as it does not require refrigeration and enables the processing of fresh, fully ripe and untreated oranges in the country of origin without having to move large amounts of water during transport.

Vitamin C levels in 100% orange juice made from concentrate are considered “high” as per EU regulations and are in the same range as the vitamin C levels in juices which were not made from concentrate, all commonly ranging from 36-53 mg/100 mL juice depending on orange variety and season, juicing processes, packaging materials, and storage conditions. In addition, hesperidin and potassium levels are similar whether 100% orange juice is made from concentrate or is freshly squeezed (Figure 2).¹⁰

Conclusion

100% orange juice contains an array of vitamins, minerals and bioactive plant compounds that is often not fully appreciated by those providing dietary advice to the public. In particular, folate, potassium and vitamin C are found in useful amounts in 100% orange juice – both freshly squeezed and packaged. These nutrients can support various aspects of health, including normal blood pressure, normal immune function and anti-oxidant processes, according to European authorities.

While fruit is rightly acknowledged as a valuable source of polyphenols, it is now clear that 100% fruit juices can be included in this category and, so, have a role to play in healthy balanced diets. In addition, a growing number of studies confirms that orange juice polyphenols, such as hesperidin, can be absorbed and utilised by the body and may deliver further, as yet not fully elucidated, health effects.

References

1. Williamson G (2017) The role of polyphenols in modern nutrition. *Nutr Bull* 42, 226–235.
2. Ruxton C (2018) What do Europe's health professionals think about fruit juice? *CN Focus* 10: 36-38.
3. Chung M et al. (2014) Nutrition education in European medical schools: results of an international survey. *Eur J Clin Nutr* 68: 844-6.
4. SGF International website <https://www.sgf.org/index.php?id=ueber-uns&L=1>.
5. Ringblom U (ed.) (2017) *The Orange Book*. Tetra Pak: Lund.
6. <https://ajjn.eu/en/publications/key-eu-legislation/the-eu-fruit-juice-directive>.
7. Rocha DMUP et al. (2017) Orange juice modulates proinflammatory cytokines after high-fat saturated meal consumption. *Food Funct* 8: 4396-4403.
8. Morand C et al. (2011) Hesperidin contributes to the vascular protective effects of orange juice: a randomized crossover study in healthy volunteers. *Am J Clin Nutr* 93: 73–80.
9. Justesen U et al. (2000) Estimation of daily intake distribution of flavonols and flavanones in Denmark. *Scand J Nutr* 44: 158-160.
10. Data provided by SGF International (2018).
11. Cerqueira e Silva LCR et al. (2014) Determination of flavanones in orange juices obtained from different sources by HPLC/DAD. *J Anal Methods Chem* 2014: 296838.
12. Manach C et al. (2005) Bioavailability and bioefficacy of polyphenols in humans. I. Review of 97 bioavailability studies. *Am J Clin Nutr* 81: 230S-242S.
13. Pereira-Caro G et al. (2014) Orange juice (poly)phenols are highly bioavailable in humans. *Am J Clin Nutr* 100: 1378-84.
14. Kindly provided by Dr Mari Cruz Arcas, AMC, Murcia, Spain.
15. Annex XIII of EU Regulation 1169/2011 <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32011R1169>.
16. Ros-Chumillas M et al (2007). Quality and shelf life of orange juice aseptically packaged in PET bottles. *J Food Eng* 79: 234-242.
17. Klimczak I et al. (2007) Effect of storage on the content of polyphenols, vitamin C and the antioxidant activity of orange juices. *J Food Compos Anal* 20: 313-322.
18. Agcam E et al. (2014) Comparison of phenolic compounds of orange juice processed by pulsed electric fields (PEF) and conventional thermal pasteurization. *Food Chemistry* 143: 354-361.
19. Aschoff JK et al. (2016) Urinary excretion of Citrus flavanones and their major catabolites after consumption of fresh oranges and pasteurized orange juice: A randomized cross-over study. *Mol Nutr Food Res* 60: 2602-2610.
20. Silveira JQ et al. (2014) Pharmacokinetics of flavanone glycosides after ingestion of single doses of fresh-squeezed orange juice versus commercially processed orange juice in healthy humans. *J Agric Food Chem* 62: 12576-84.
21. http://ec.europa.eu/food/safety/labelling_nutrition/claims/register/public/?event=register.home.

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