100% fruit juice and metabolic health

Introduction

There is a belief that 100% fruit juice (100%FJ), on account of its natural sugar and low fibre levels, as well as its liquid format, could have a detrimental impact on blood glucose control and body weight.

However, these views are often based on assumptions rather than solid evidence. This article will review recent studies that have considered these issues.

Glycaemic control

It is known that foodstuffs with a high glycaemic index (GI) or load, e.g. white bread or glucose drinks, will rapidly boost post-prandial blood glucose levels. Is this the case for 100%FJ?

A recent meta-analysis[1] collated evidence from 18 randomised controlled trials (RCTs), involving 960 adults, which examined the impact of 100%FJ on markers of glycaemic control. Many of the participants were overweight or had metabolic risk factors, such as hypercholesterolaemia or type 2 diabetes (T2DM).

Compared with controls, 100%FJ had no significant impact on fasting blood glucose, HOMA-IR[a], insulin or glycosylated haemoglobin levels (a marker of long-term glucose levels). This suggests that 100%FJ has a *neutral* effect overall on glycaemic control.

Another meta-analysis[2] examined 12 RCTs involving 412 adults who were either obese or had risk factors for T2DM or cardiovascular disease. In half of the studies, fruit juice intakes were 400ml per day or more. However, the findings were similar to the previous meta-analysis, observing that 100%FJ consumption did not significantly affect fasting glucose or insulin levels.

Subgroup analysis revealed that the findings were unaffected by baseline glucose levels, study duration, type of fruit juice, glycaemic index of fruit juice and quality of the study suggesting a consistent effect across these 'at risk' populations

Two factors may be driving these results. Contrary to expectations, 100%FJ do not have a high GI. International GI tables[3] reveal that 100% apple juice has a GI of 41 while 100% orange juice has a GI of 50 – both are lower than accepted lower GI foods such as wholewheat bread and cooked oatmeal.

Another reason may be the high levels of polyphenol compounds in 100%FJ. These have been proposed to have an important role in glucose-insulin regulation as they appear to inhibit glucose absorption, stimulate insulin secretion and glucose uptake by cells, and modulate cell signalling pathways as well as gene expression[1].

[a] HOMA-IR; Homeostatic Model Assessment of Insulin Resistance. A tool to assess beta cell function and insulin sensitivity.

Diabetes risk

Two meta-analyses have been published based on prospective observational data. This means that they can determine associations but not cause and effect.

The first[4] examined four prospective cohorts and concluded that 100%FJ consumption was not related to the risk of T2DM onset (RR = 1.03, p = 0.62).

The second[5] evaluated associations with consumption of sugar-sweetened soft drinks (17 studies), artificially sweetened soft drinks (10 studies) or 100%FJs plus fruit juices with no added sugars (13 studies). The results showed that high intakes of all of these beverages (>250ml daily) significantly increased risk of T2DM. With regard to 100%FJ, the relative risk was small at 1.07 and only achieved statistical significance after adjusting for several confounding factors, including adiposity. The authors commented that the results for 100%FJ (unlike for sugary drinks) should be interpreted with caution due to their poor quality.

CVD risk factors

It is well recognised that eating fruit and vegetables is associated with lower mortality and risk of chronic diseases[6]. Several studies have investigated whether consuming these as beverages can deliver similar benefits.

Metabolic syndrome (MetS) – This is a cluster of interconnected factors that increase the risk of heart disease. The International Diabetes Federation[7] definition is shown in Table 1.

Silveira and colleagues[8] carried out an 8-week trial where volunteers drank 100% red orange juice (high in lycopene) daily over 8 weeks. Compared with the control group, orange juice intake led to lower blood pressure and insulin resistance, as well as evidence of anti-inflammatory, antioxidant and lipid-lowering effects. These combined effects may help to reduce the risk of MetS.

Table 1: Definition of MetS

Central obesity **plus** any two of the following:
• Raised triglycerides (≥ 150 mg/dL)
• Reduced HDL cholesterol (<40 mg/dL in males; < 50 mg/dL in females)
• Raised blood pressure (systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg)
• Raised fasting plasma glucose (≥ 100 mg/dL) or previously diagnosed T2DM.

Lipid Profile – One trial[9] recruited adults with elevated or normal cholesterol levels and allocated them to drink either 750ml daily of orange juice from concentrate (i.e. no added sugar) for 60 days versus a 'no juice' control.

Amongst those with elevated cholesterol levels at baseline, low density lipoprotein cholesterol (LDL-c) was significantly reduced by the end of the trial, while high density lipoprotein cholesterol (HDL-c) was raised– findings suggesting that orange juice may facilitate free-cholesterol transfer to HDL-c.

Other work[10] on HDL-c has produced similar results. Twenty-five healthy Canadian men and women with elevated total cholesterol levels were allocated to drink 1, 2 or 3 cups (250ml) of 100% orange juice daily over three 4-week periods followed by a 5-week washout where no juice was consumed.

Drinking 750ml juice daily, but not 250ml or 500ml, significantly increased HDL-c by 21% by the end of the trial (Figure 1) indicating that this could be of benefit to those with raised cholesterol levels.

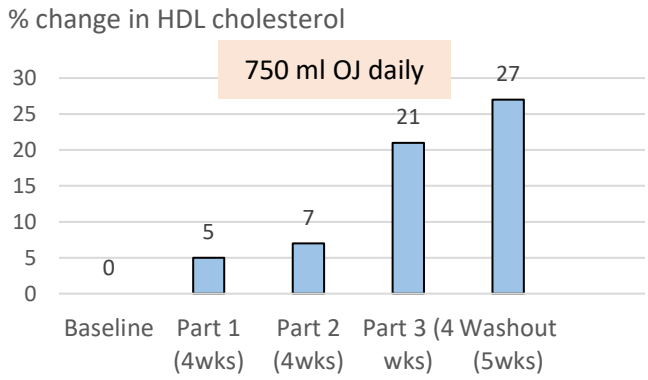

Figure 1: Percentage change in HDL-c after daily orange juice consumption.

Orange juice may also influence lipid levels in active populations. In one study, 13 women[11] drank 500ml orange juice daily and participated in 1 hour of aerobic training 3 times weekly over 3 months. Their LDL-c levels significantly reduced by 15% whilst HDL-c increased by 18%. No significant changes were noted in the control group

Interestingly, in the orange juice group only, blood lactate levels reduced and physical performance improved. High blood lactate is a common cause of exercise cramps and muscle soreness[11].

Mechanisms – In terms of potential mechanisms, cardiovascular benefits may relate to the high hesperidin content of citrus fruits. Hesperidin is a flavone mostly found in orange and lemon.

A French RCT[12] recruited 24 overweight men and randomised them to drink 500ml orange juice, a control drink with hesperidin, or a placebo drink over 4 weeks. The results showed that both orange juice and hesperidin significantly reduced diastolic blood pressure and improved endothelium-dependent microvascular reactivity (an indicator of how well the lining of blood vessels constrict or relax). This suggests that the vascular benefits of oranges and 100% orange juice are probably due to hesperidin.

Similarly, another French trial[13] found that the consumption of blond (yellow) orange juice (up to 600ml daily) over 4 weeks significantly increased antioxidant levels. This, in turn, correlated to hesperitin plasma levels and a reduction in harmful reactive oxygen species.

Other work[14] has found that orange juice consumption can lead to the short-term elevation of 8 different flavanones and 15 phenolic compounds. Flavanones are soluble compounds which are found in the juice cloud, rather than in cell walls which explains their increased bioavailability in juice compared with whole fruits[15].

It is thought that drinking mixtures of juices could help with aspects of the cardiovascular system by providing an array of polyphenols and vitamins which have their own biological effects.[16]

Weight management

There is a belief that 100%FJ consumption contributes to weight gain, a view that is not supported by the scientific literature.

A recent trial[17] assigned 78 obese patients to drink 500 ml of 100% orange juice or a control drink daily over 12-weeks. Daily orange juice, at intakes more than twice the levels recommended in Europe, did not inhibit weight loss (Figure 2) yet increased vitamin C and folate intakes by 62% and 39%, respectively. Energy intakes were unaffected while insulin and lipid profiles were significantly improved in the juice group relative to the control.

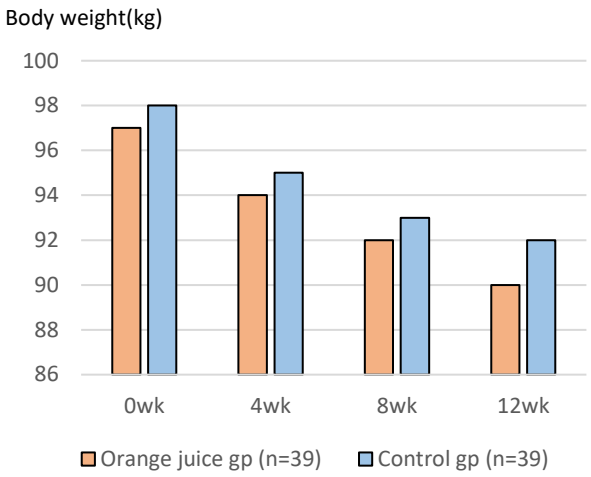

Figure 2: Drinking 500ml orange juice daily over 12-weeks did not prevent weight loss.[14]

Another trial[18], this time non-randomised or controlled, invited 25 normal weight and 25 obese participants to consume 750ml of 100% orange juice daily for 8 weeks. At the end of the study, there were no statistically significant changes in body composition indicating that the calories from the orange juice had been compensated. Beneficial changes in both obese and normal weight groups were noted for total cholesterol, LDL-c, CRP (a marker of inflammation) and total antioxidant capacity.

Interestingly, when looking at associations in children a review of 22 studies[19] found that 100%FJ consumption helped to deliver beneficial nutrients without contributing to paediatric obesity. This is supported by a recent meta-analysis of 8 prospective studies, involving more than 34,000 children, which found no statistical or clinical association between 100%FJ consumption and body mass index z-scores[20].

Conclusion

These published clinical studies suggest that 100%FJ, especially orange juice, is associated with the following effects:

- No unfavourable impact on blood glucose or insulin levels, and no statistically significant association with risk of T2DM;
- Reduced levels of total and LDL cholesterol and higher levels of HDL cholesterol;
- Providing a source of hesperidin alongside an array of polyphenols and vitamins that have antioxidant activity in the body;
- No demonstrable impact on body composition in adults, nor weight gain in children, even when consumed by overweight adults with or without an energy reduced diet.

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