Vegans, vegetarians and omnivore diets differ in nutrient hedonics, flavouring and salt and sweet taste.

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Research Article

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Abstract

Purpose

Dietary content can influence taste responses. Therefore, we compared nutrient hedonics (liking foods

by nutrient content), and seasoning, including taste responses to the prime flavours salt and sweet in vegans (16 men 14 women), vegetarians (38, 24) and omnivores (55, 38).

Methods

Questionnaires and taste tests examined macronutrient and electrolyte intake and hedonics, seasoning, salt and sweet preferences and psychophysical taste responses.

Results

Compared to omnivores, vegans had lower protein, Ca^{++}, Na^{+} intake, and increased CHO intake. Independently of intake, hedonics for protein Ca^{++} and Na^{+} were reduced and increased for CHO. Psychophysical responses to NaCl and sucrose also differed slightly, vegans and vegetarians scoring high concentrations of sucrose as more intense, Vegans reported more sweetening and less salting of food, added more sucrose to a test tea, less salt to a test soup, but did not differ in seasoning with oil or hot spice.

Conclusion

Habitual vegan, vegetarian and omnivore diets may alter taste responses to nutrient content and salt and sweet, the latter more pronounced in vegan and vegetarian women. Recognising diet-dependent changes in taste hedonics can inform diets and products.

1. Introduction

Vegan and vegetarian diets have traditionally been to reduce animal exploitation and benefit health, and recently have gained increased popularity because of nutrition science, health recommendations, and environmental sustainability [1–7].

The three diets differ in nutrient composition [3, 6, 8–11]. Animal studies show that nutrient status, such as dietary fat or sodium, may alter taste responses appropriately by innate mechanisms or conditioning associated with bodily states [12–16]. There is evidence for similar mechanisms in humans: status of calories, protein, fat, carbohydrate, Ca^{++} and Na^{+} may drive intake via appetite and hedonism by association with consumption of foods with beneficial nutritional and other outcomes, eg, satiety [17–38]

Thus, nutrient want can alter associated taste hedonics appropriately, which for brevity we term ‘nutrient hedonics’. Hence, we hypothesise that nutrient hedonics for the above macronutrients and electrolytes will differ in vegan, vegetarian, and omnivore diets.

Taste hedonics also reflect culture, family dietary habits, health advice and beliefs and are a guiding factor in diet selection and improved nutrition [14, 39, 40]. Changes in taste sensation can therefore have implications for adherence to diet, dietary choice and intake, seasoning including salt and sugar (arguably the most extant seasonings) and body weight [35, 41]. To date, there is only one study of taste in vegans, vegetarians and omnivores, showing detection threshold differences [42].

Hence, here we examine nutrient hedonics (for macronutrients and electrolytes) in vegan, vegetarian and omnivore diets and on seasoning with, and taste responses to, the prime discretionary flavours salt and sweet.

2. Method

2.1 Participants

Ethics approval was provided by the department of psychology ethics committee. Recruitment was among university students via online notices and friends-bring-friends. There was no remuneration, but some psychology students were granted academic credits. Participants signed informed consent forms and included self-defined omnivores (55, 38 women), vegetarians (38, 24), and 39 vegans (16 men 14 women, cf below). Sample size was chosen based on similar studies [9, 11, 26, 28, 30, 42, 43]. Sex was by self-report (distribution, Chi2 = 4.18, NS).

Table 1 presents the basic data. There were no group or sex differences for age, BMI, home cuisine, alcohol intake, smoking, dietary supplement use, chronic illness or medications, although activity was lower in women (MWU, p = 0.036, not detailed).

-Table 1 here –

Table 1
demographics (± SE)

	Vegan	Vegetarian	Omnivore
Age	22.0 ± 0.8	24.6 ± 1.7	23.4 ± 0.3
Body weight (Kg) ▯	59.9 ± 2.1	61.0 ± 2.5	57.2 ± 1.4
Body Weight (Kg) ▯	65.0 ± 3.3†	76.7 ± 5.6*	75.6 ± 3.4*
BMI	20.0 ± 0.6	22.5 ± 0.7	22.7 ± 0.5
% smokers	20.0	16.2	33.9
cigarettes/d[1]	5.6 ± 2.4	6.5 ± 2.8	10.5 ± 1.5
Years on diet	3.7 ± 0.5†	8.7 ± 1.1	-
Activity	62.8 ± 2.4	63.9 ± 1.9	60.4 ± 1.3
*Body weight sex difference, p < 0.01. †p < 0.001 differ from vegetarians. [1]smokers only.			

2.2. Missing data

Due to data mishap, sex of 9 vegans and age for 66 participants was lost, although participants were students or of a similar age range.

2.3 Procedure

Participants were asked to avoid smoking, eating and drinking except water for two hours before the test sessions. The session commenced with signing the informed consent form including a brief explanation in general terms that participants would be asked to complete questionnaires about their demographics and diet and evaluate the taste of various common food items and tastes. Throughout, salt and sugar were not mentioned as such, but as ‘flavours’. Participants then completed the demographic questionnaire and were tested for preferred concentration of salt in soup and sugar in tea, followed by taste tests with oral sprays of NaCl and sucrose solutions. Between the tests, participants were interviewed to complete the dietary, seasoning, and preference questionnaire.

The session ended with weight and height measurement and lasted 60–80 minutes [25, 44].

Questionnaires

Demographic

The demographic questionnaire queried which of the 3 diets the participant adhered to, sex, main cuisine (5 extant ethnic patterns in Israel), general and sport activity (8 items), attitudes to their vegan or vegetarian diet (7 items), diets adhered to or restricted, familial diets, health, medication and more.

2.4.2 FFQ

The FFQ was modified from the Ministry of Health FFQ [45] and additional sources and covered some 84 foods of the common Israeli diet, including vegetarian and vegan foods. It was completed together with a trained researcher and provided the following scores:

Dietary intakes

Participants were asked about their weekly frequency of consumption of food items which served to calculate daily energy, macronutrient and electrolyte content using nutritional values and standard portion size tables.

Seasoning

Participants were asked much sugar, salt, hot (peppery) spice, and oil (commonly olive oil) they add to appropriate foods in the FFQ (4 levels each).

Nutrient Hedonics

Participants scored each food for liking on a 5-point scale from “dislike very much” (-2) to “like very much” (2, Hebrew). To examine the relation of hedonism and nutrient independently of the amount eaten, the caloric, macronutrient and electrolyte content by 100g of each food eaten by a participant was multiplied by its hedonic score and averaged to provide the nutrient hedonic score [28, 30].

2.4 Behavioural tests of salt and sweet preference

2.5.1 Preferred concentration of salt in soup and sugar in tea

This test is proposed as a lab simulation of ‘real-life’ salting and sweetening [45, 46]. Tomato soup was prepared by diluting 1 part of 100%, (unsalted) tomato paste (22BX) with nine parts of bottled water (Na^+ 9mg/l). Tea was prepared with a 3 g tea bag in 1l water. The soup and tea were prepared before each test session and kept in vacuum flasks at ~ 45°C.

Participants were presented with two 200 ml cups of tomato soup, one unsalted and one with 3.3% (w/w) NaCl. They were asked to taste the soup in both cups using a 5 ml teaspoon and were provided with a third cup into which the experimenter poured one-half of the unsalted soup. Then, using the teaspoon, they were asked to add ‘flavoured’ (salted) or unflavoured soup to the third cup, tasting and adjusting until they deemed the mixture most "tasty". The salt concentration of the mixture was determined by weighing the cups, a validated measure of concentration. Preference for sucrose in tea was similarly determined, ‘flavoured’ with 20% (w/w) sucrose [25, 44, 47].

2.5.2 Psychophysical ratings of salt & sucrose solutions in oral sprays using visual analogue scales (VAS)

This was employed to rate intensity and hedonics of suprathreshold taste stimuli [30]. Solutions were diluted to 6 concentrations with bottled water (9 mg/l sodium): NaCl from 2.56 M by 1/3 steps down to a concentration of 2.5 mM, sucrose from 135 g/l by 1/2 steps dilution to 0.55 g/l. Using calibrated perfume bottles, the experimenter sprayed 0.29 ml onto the participant’s tongue of each taste concentration in one of 4 fixed and counterbalanced semi-randomized orders (excluding sequential concentrations). The VAS was an on-screen unmarked horizontal line and, using a mouse,

participants rated each concentration for taste intensity (“how strong is the taste?”) anchored at the ends by “don’t feel anything” and “very strong”, and for hedonics (“how tasty is it?”) anchored by “bad taste” and “very tasty” with a centred tick mark. The program scored mouse-click placement between 0 and 100.

2.6 Salt Appetite and sweet preference summary scores

In order to gain a perspective on the various forms of salt and sweet intake and preferences, ‘Salt Appetite’ summarised the combined (unweighted, mean ranks) of the above measures (liking score of dietary sodium, dietary salting, preferred concentration of salt in soup, and mean hedonic score of the two highest concentrations of sodium spray (which all participants discerned)). Equivalent ‘Sweet Preference’ measures were calculated (dietary sweetening, preferred concentration of sugar in tea, and sucrose sprays) [25, 44, 46].

2.7 Statistical analysis

Analyses (IBM SPSS 27) employed general linear models, univariate, multivariate or repeated (UNOVA, MANOVA) as appropriate to compare the diets. Analyses used energy and body weight as covariates for intake measures, and smoking (cigarettes/day) which can influence taste, for hedonic measures [48]. Non-parametric analyses were employed as reported. The Bonferroni adjustment for multiple comparisons served. For correlations (Spearman) $p > 0.001$ was not considered significant to account for multiple comparisons. For brevity, non-significant differences are not specified unless noteworthy for further analysis or discussion. Analyses of sex differences are reported, but for brevity, not detailed when marginal to the aims of the study. SEM indicates variance throughout.

3. Results

3.1 Questionnaires

3.1.1 Demographic

Summaries are presented in Table 1

Cuisine. Home cuisine did not differ significantly between groups; about 38% reported East European cuisine, 27% Eastern, 14% West European, 12% “more than one ethnic diet”, 1% Ethiopian and 7% “other”.

Alcohol

About half of vegans and vegetarians and ~ 70% of omnivores drank alcohol, Chi^2 (2, N-123) = 6.23. $p = 0.044$. but compared to alcohol-consuming countries intake was negligible (Table 3).

Dietary restrictions

There were no group or sex differences in dietary restriction of calories, fat, sugar, CHO, or any other diet type, except for salt with 50% of vegans restricting, 30% of vegetarians, and 20% of omnivores, $Chi^2(2,N = 123) = 8.56$, $p = 0.013$, and 50% of men restricting *vs.* ~25% of women, $Chi^2(1, N = 114) = 11.1$, $p < 0.001$.

Length of adherence to the diets

UNOVA by group and sex of length of adherence to the diets (vegan & vegetarian) revealed an effect of diet $F(1,58) = 7.22$, $p = 0.009$ (Table 1) and an interaction with sex, $F(1,58) = 6.77$, $p = 0.012$, PES = 0.105, possibly due to similar vegan adherence by sex whereas vegetarian women had adhered for longer than vegetarian men (ns).

3.1.2 FFQ

Dietary intakes

Detailed differences are presented in Table 2. UNOVA's were adjusted for body weight for energy comparisons, and for weight and energy intake for macronutrients and electrolytes. Energy intake did not differ by diet group, ($F(2,107) = 3.03$, $p = 0.052$, PES = 0.054, but tended to be lower in vegans than omnivores, $p = 0.046$, and was lower in women ($F(1,107) = 12.8$, $p = 0.001$, PES = 0.107). As expected, calories from animal products showed an effect of diet, ($F(2,107) = 39.5$, $p < 0.001$, PES = 0.425, sex $F(1,107) = 5.51$, $p = 0.021$, PES = 0.049, and the interaction, $F(1,107) = 3.72$, $p = 0.027$, PES = 0.065, due to lower intake by women omnivores compared to omnivore men, $F(1,48) = 14.3$, $p < 0.0005$ (not detailed). For protein there was a diet group effect, $F(2,106) = 32.4$, $p < 0.001$, PES 0.380 due to greater omnivore intake, and a diet-sex interaction, $F(2,106) = 3.9$, $p = 0.023$, PES = 0.069, due to omnivore women ingesting less protein than omnivore men, $F(1,48) = 10.6$, $p < 0.002$ (not detailed). Fat intake did not differ by diet or sex. There was an effect of diet for carbohydrates $F(2,106) = 14.8$, $p < 0.001$, PES = 0.219, due to lower omnivore intake, a diet effect for calcium, $F(2,106) = 6.0$, $p = 0.003$, PES = 0.102, due to low vegan, but high vegetarian intakes, and for sodium, $F(2,106) = 5.9$, $p = 0.004$, PES = 0.100, higher in omnivores. There were no significant differences for potassium.

Corrected for body weight women ingested less energy, fat, CHO and potassium (not detailed).

Seasoning

Seasoning with oil or spice did not differ by diet group. For salting, there was a diet effect, KW)2, N = 123) = 14.9, $p = 0.001$, due to vegans and vegetarians salting less than omnivores (Table 2). Women salted more than men MWU)N = 114) = 1,876, $p = 0.009$, 0.33 ± 0.04 *vs* 0.21 ± 0.03. For sweetening there was a diet effect, KW)2, N = 123) = 8.76, $p = 0.013$, vegans sweetening more than omnivores (Table 2).

- Table 2 here –

Nutrient Hedonics

MANOVA of nutrient hedonic scores by 100g of foods (7) by diet group (3) and sex (2) with smoking and body weight covariates revealed an effect of diet, $F(14,202) = 13.5$, $p < 0.0001$, PES = 0.483, due to vegans rating their nutrients as least hedonic and omnivores most, with vegetarians midway. There were no sex effects (Table 3).

Corrected for smoking and energy intake, hedonic scores for foods did not differ, $F(2,106) = 1.20$.

Nutrient hedonics and intake correlated for protein, $r = 0.48$, Ca^{++}, $r = 0.35$ and Na^{+}, $r = 0.39$, p's < 0.0001, but not for energy, fat, CHO or K^{+}.

- -Table 3 here –

Table 2
Questionnaires: FFQ[1] and seasoning by dietary group.

	Vegan	Vegetarian	Omnivore
Kcal	1928 ± 133	2076 ± 205	2176 ± 139
Kcal animal	6 ± 75^{v3o3}	600 ± 67	715 ± 55
protein g	49.8 ± 3.9^{o3}	70.6 ± 7.3	91.0 ± 6.2
fat g	58.5 ± 6.4	64.9 ± 6.8	75.0 ± 5.8
CHO g	305 ± 22^{o3}	304 ± 31^{o2}	283 ± 18
Ca^{++} mg	551 ± 47^{v2}	962 ± 116	772 ± 55
Na^{+} mg	1514 ± 160vo	2217 ± 232	2214 ± 147
K^{+} mg	3037 ± 206	2607 ± 251	2661 ± 145
EtOH[2] (ml/d)	7.7 ± 1.7	7.0 ± 1.5	8.3 ± 1.1
Na^{+}/K^{+}	0.543 ± 0.056^{v3o2}	0.938 ± 0.077	0.867 ± 0.046
Sweeten food[3]	0.31 ± 0.02^{o}	0.32 ± 0.03	0.23 ± 0.02
Salting foods[3]	0.16 ± 0.03^{vo3}	0.26 ± 0.03	0.37 ± 0.05
Add hot spice[3]	0.08 ± 0.03	0.07 ± 0.02	0.10 ± 0.02
Add oil or fat[3]	0.20 ± 0.03	0.27 ± 0.05	0.24 ± 0.02

[1]Significance adjusted for energy (except Kcal) and body weight for dietary intakes. [2]Drinkers only. In data columns superscript letters denote difference from vegetarian (v) or omnivore (o), $p < 0.05$, superscript numbers 2, $p < 0.01$, and 3 $p < 0.001$, Bonferroni adjusted. [3]Kruskall-Wallis, Bonferroni adjusted.

3.2 Behavioural tests of salt and sweet

3.2.1 Preferred concentration of NaCl in soup and sugar in tea

For salt added to the test soup, UNOVA by group (3) and sex (body weight and smoking adjusted) revealed an effect of diet group, $F(2,105) = 5.15$, $p = 0.007$, PES = 0.089, because omnivores added more salt (Table 4).

For sugar added to the test tea, UNOVA by group and sex (body weight and smoking adjusted) revealed an effect of diet group, $F(2,105) = 3.76$, $p = 0.027$, PES = 0.067 because vegans added more sugar (than vegetarians, Table 4).

- Table 4 here –

3.2.2 Psychophysical ratings of taste solutions

Sucrose and NaCl taste intensity

UNOVA for sucrose intensity by group (3), concentration (6) and sex (adjusted for smoking), as expected, revealed an effect of concentration, $F(5,530) = 124.5$, $p < 0.0001$, PES = 0.540 (Fig. 1, top). Separate analysis suggested omnivores found the

highest concentration of sucrose less intense for concentration 6, $F(5,530) = 153.0$, $p < 0.0001$, PES = 0.591. compared to vegans and vegetarians respectively, p's < 0.01 and 0.0005 (Fig. 1, top).

Similar UNOVA for NaCl intensity revealed only the expected effect of concentration, $F(5,530) = 124.5$, $p < 0.0001$, PES = 0.540 (Fig. 1, top).

Table 3
MANOVA data for nutrient hedonics by 100g foods and diet group

nutrient	nutrient hedonic score			diet group effect		
	vegan	vegetarian	omnivore	F(2,106)	p < 0.	PES
Kcal	830 ± 15	829 ± 16	856 ± 13	0.561		
Protein	18.6 ± 0.7^{v3o3}	24.4 ± 0.7^{o3}	31.5 ± 0.6	83.7	0001	0.612
Fat	52.4 ± 0.9	52.1 ± 1.0	55.5 ± 0.8	0.722		
CHO	89.1 ± 2.0^{o2}	81.6 ± 2.1	79.0 ± 1.7	5.28	007	0.091
Ca^{++}	151 ± 11^{v3o3}	302 ± 13	292 ± 10	53.6	0001	0.503
Na^{+}	762 ± 40^{vo3}	927 ± 44	984 ± 36	8.76	0001	0.142
K^{+}	686.3 ± 25	647.3 ± 27^{v}	713.7 ± 22	1.78		

Significance adjusted for smoking. Superscript letters denote difference from vegetarian (v) or omnivore (o), $p < 0.05$, superscript numbers 2, $p < 0.01$, and 3 $p < 0.001$, Bonferroni adjusted.

Table 4
Tests of salting soup & sweetening tea, and summary scores

	Vegan	Vegetarian	Omnivore
% salt in soup	0.821 ± 0.085^{o}	0.829 ± 0.053^{o2}	1.081 ± 0.050
% sugar in tea	10.10 ± 1.02^{v}	7.55 ± 0.48	9.14 ± 0.48
Salt Appetite	50.1 ± 4.0^{o3}	59.1 ± 4.2	71.6 ± 3.4
Sweet preference	67.4 ± 4.3	57.4 ± 4.5	59.9 ± 3.6

Superscript letters denote difference from vegetarian (v) or omnivore (o), $p < 0.05$; superscript numbers 2, $p < 0.01$, 3, $p < 0.0005$, Bonferroni adjusted.

Sucrose and NaCl taste hedonics

UNOVA for sucrose hedonics by group (3), concentration (6) and sex (adjusted for smoking), as expected, revealed an effect of concentration, $F(5,530) = 32.5$, $p < 0.0001$, PES = 0.235 and sex $F(1,106) = 12.6$, $p < 0.001$, PES = 0.107, women scoring higher intensity (not detailed) (Fig. 1, bottom).

Similar UNOVA for NaCl hedonics revealed the expected effect of concentration, $F(5,530) = 16.4$, $p < 0.0001$, PES = 0.134, and sex $F(1,106) = 7.36$, $p = 0.008$, PES = 0.065, women scoring lesser aversion (not detailed) (Fig. 1, bottom).

-Figure 1 here-

3.3 Salt Appetite and sweet preference summary scores

MANOVA for the 3 diet groups, sex, salt appetite and sweet preference (body weight and smoking adjusted) showed an effect of diet, $F(4,206) = 4.60$. $p < 0.001$, PES = 0.082, due to greater omnivore than vegan Salt Appetite $F(2,103) = 6.80$. $p < 0.002$ (Table 5), and a diet by sex interaction for sweet preference, $F(2,103) = 3.32$. $p = 0.040$, PES = 0.061, because vegan and vegetarian women had a greater sweet preference than vegan and vegetarian men, but the opposite was true for omnivores (not detailed).

3.4 Correlations between behavioural tests and FFQ scores (Table 5).

The correlations between the behavioural tests and analogous "pen and paper" FFQ scores suggested internal consistency of the measures (table 6).

-table 5 here –

Table 5
Correlations between reported (FFQ) and tested salting and sweetening

		reported	
		Dietary Sweetening	Dietary Salting
Tested	Sugar in tea	0.30***	0.15
	Salt in soup	0.09	0.39****
***p < 0.001, ****p < 0.0001, n = 122.			

4. Discussion

4.1 Findings

Questionnaires, taste, preference and psychophysical tests showed that vegan, vegetarian and omnivore diets may induce different hedonic and sensory taste responses and seasoning. The cross-sectional data relating diet to these differences is correlative but suggests causation because there is no evidence that taste sensation and hedonics *a priori* determine these diets and lifestyles whereas evidence for effects of diet and lifestyle on food preferences and hedonics is plentiful [12, 17, 19, 20, 21, 22, 26, 29, 32, 35, 36, 37, 40, 41, 49].

Consistent with other reports, in our sample, protein, fat, Ca^{++}, Na^{+} intakes, and Na^{+}/K^{+} were lower in the vegan compared to omnivore diet [8, 9, 11, 43, 50]. Vegan and vegetarian diets were richer in carbohydrates, possibly as a source of energy (64% in vegans, 59 in vegetarians, 52 in omnivores, $p < 0.0001$) compensating for their lower energy intake from protein and possibly fat [11, 39].

Lending some support for our hypothesis, compared to omnivores, vegans evinced reduced hedonics by 100g food for protein, Ca^{++} and Na^{+} but increased hedonics for CHO with vegetarians generally in between. For protein, this contrasts with evidence from experiments with brief reduced protein intake, particularly when dietary protein intake is high, and hedonics for protein associated foods (or umami taste) increases [23, 24, 31, 34]. Arguably, there is some evidence for Ca^{++} nutrient hedonics [51], as there is for Na^{+} [46]. Vegan reduced Na + intake and hedonics may also be due to health considerations, as much as increased Na^{+} intake for omnivores is for considerations of taste [4]. Overall, hedonics for foods did not differ between the diets.

It is also possible that the lower vegan hedonics and intakes for the nutrients, except CHO which was also higher in intake, may serve to maintain lower nutrient intakes and adherence to the diet. Nutrient hedonics and intakes correlated for protein, Ca^{++} and Na^{+}, suggesting that for these nutrients hedonics may drive intake. Similar effects, ie lower hedonics and intake, have been noted for salt in long-term diets, possibly sustaining adherence to the low sodium diet [19, 20].

Vegans salted their food and a test soup less, half of them reported restricting dietary salt, and consequently summary Salt Appetite was lower. On the other hand, vegans sweetened their diet more, scored high concentrations of sweet as more intense, and added more sugar to a test tea. A recent report notes vegan and vegetarian lowered threshold sensitivity to sweetness although the relationship of threshold and suprathreshold taste sensation is moot [35.42]. Possibly too, sucrose is preferred as CHO. Oil and spice seasoning did not differ between the diet groups.

4.2 Sex differences

Although sex differences were not the primary aim of the study, since many more women than men are vegan or vegetarian, sex differences are likely [52]. Vegetarian and omnivore women ate less animal-derived calories, and consistently scored all nutrient hedonics lower than vegetarian and omnivore men. Vegan and vegetarian women had a greater sweet preference than vegan and vegetarian men, possibly because vegetarian men, more than vegetarian women, justified their diet for health (KW (1, N = 32) = 11.32, p = 0.001).

Vegan men weigh less than the other men, remarkably like Swedish vegan men, whereas vegan women did not differ in weight from the other women [9].

Overall, women scored hedonics of salt and sucrose solutions higher than men, salted more than men, and less than half as many reported dieting.

4.3 Limitations and strengths

It is likely that hedonics and taste responses relate to other components of diet we have not tested, nor do we know how representative our sample is because the taste phenomena we report have scarcely been examined. Additional taste tests, of sour, bitter, umami and tests of possible changes in related food choices would be of interest in expanding the understanding of diet-induced alterations but were beyond the scope of this study. Here we limited our study to salt, sweet, spice and oil, as discretionary flavours commonly added to food at table, whereas sour, bitter, and umami are less so.

FFQ's are of limited validity in terms of actual dietary intake, however, here they were used to compare samples, and the true amounts ingested are of lesser concern, although reporting bias might be different among groups with ideological or other underpinnings for their diet [53, 54].

Our study also has strengths: the use of multiple measures to assess taste preferences, the homogenous sample, and results consistent with other reports [9, 43, 50, 53], and the relation of smoking, salt appetite and alcohol we find is consistent with very large studies [48].

Also lending credence to our findings was the consistency of the behavioural tests and FFQ respectively showing that compared to omnivores, vegans added less salt to soup and most sugar to tea, and less dietary salting and greater dietary sweetening. Moreover, the correlations between behavioural tests and analogous "pen and paper" FFQ scores suggest internal consistency (table 6).

4.4 Conclusions

Sustained adherence to vegan, vegetarian and omnivore diets may engender comprehensive changes in nutrient hedonics, tastes and flavours, with some sex differences. Such changes may sustain adherence to diet. Recognising diet-dependent changes in taste perception and hedonics can inform diets and food products for vegans, athletes, the elderly, after bariatric surgery, in disease, etc [29, 41, 42, 55, 56].

Declarations

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ML and SS report no conflicts of interest. ML designed the research; ML and SS conducted the research and analysed data and wrote the paper. ML has primary responsibility for final content. Both authors read and approved the final manuscript.

ETHICAL STANDARDS

These human have been approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

All persons gave their informed consent prior to their inclusion in the study. Details that might disclose the identity of the subjects under study are omitted. The manuscript does not contain clinical studies or patient data.

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Table 6

Table 6 is not available with this version.

Figures

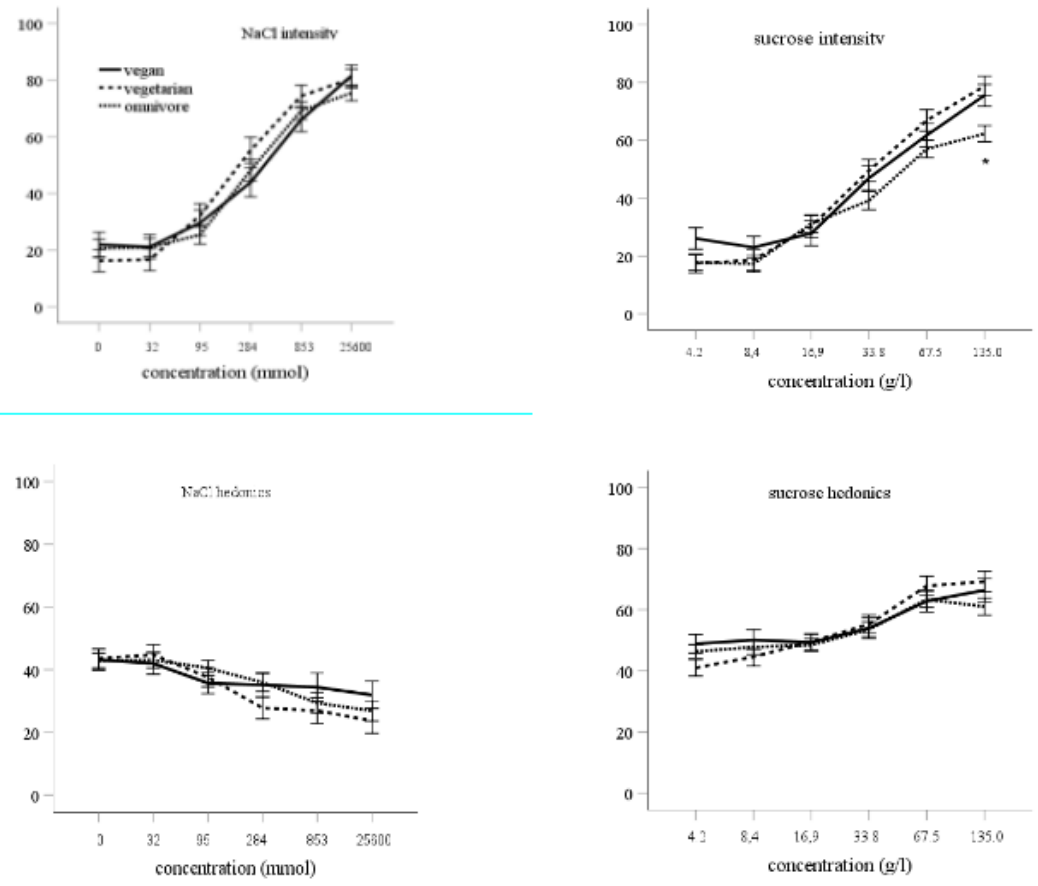

Figure 1

VAS curves for intensity (top) and hedonics (below) for different concentrations of NaCl (left) and sucrose (right). Vegans, line, vegetarians, dashes, and omnivores, dots. *Omnivores differ from vegans and vegetarians, p's<0.01. cf section 3.2.2 *Sucrose and NaCl taste hedonics* for sex effects