ARTICLE TYPE
Original research

TITLE
Co-ingestion of a commercially-available dandelion root powder elicited no additional diuretic effect over 4 hours compared to ingestion of water alone in physically-active young adults

RUNNING TITLE
No diuretic effect of dandelion root powder

AUTHORS
Jack Gavin[1*], Caroline Caulfield[2*], Brendan Egan[1,3]
[*]joint first author contribution

AFFILIATIONS
[1]School of Health and Human Performance, Dublin City University, Dublin, Ireland
[2]School of Agriculture and Food Science, University College Dublin, Dublin, Ireland
[3]Florida Institute for Human and Machine Cognition, Pensacola, FL USA

ORCIDs
Brendan Egan 0000-0001-8327-9016

CORRESPONDING AUTHOR
Brendan Egan, PhD
School of Health and Human Performance
Dublin City University
Glasnevin, Dublin D09 V209
Ireland
e: brendan.egan@dcu.ie
t: +353 1 7008803
f: +353 1 7008888

ABSTRACT WORD COUNT	**246**
MAIN TEXT WORD COUNT	**4385**
NUMBER OF REFERENCES	**37**
NUMBER OF TABLES	**0**
NUMBER OF FIGURES	**3**

AUTHOR CONTRIBUTIONS
Jack Gavin: Conceptualization; Data curation; Investigation; Roles/Writing - original draft;
Caroline Caulfield: Data curation; Investigation; Roles/Writing - original draft;
Brendan Egan: Conceptualization; Data curation; Formal analysis; Supervision; Writing - review & editing.

ACKNOWLEDGEMENTS
We thank Dr. Brijesh K. Tiwari (Ashtown Teagasc Food Research Centre, Dublin, Ireland) and team for performing the compositional analysis of the capsules. No conflict of interest, financial or otherwise, is declared by the authors. The authors declare the results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

ABSTRACT

Athletes in weight category sports frequently practice short-term weight loss to make weight, which often involves manipulation of total body water. In Eastern medicine and phytotherapy, dandelion has long been considered to have a diuretic effect, yet empirical investigations of this effect are scarce. This study investigated whether the ingestion of a commercially-available dandelion root powder with a large bolus of water acutely elicited a diuretic effect beyond the effect on urine output elicited by the bolus of water alone. In an open-label counterbalanced, crossover design with two separate laboratory visits, physically-active young adults (n=14; M/F, 12/2; age, 25.5±4.7 y) ingested 1 L of still water with (DAND) or without (CON) four capsules providing a total of ~2.1 g of a commercially-available dandelion root powder. The primary outcome was cumulative urine output over the 4 h following ingestion. Cumulative urine output was 1164±244 g in CON and 1268±213 g in DAND, with the mean difference (95% confidence interval) of 105 (-35 to 244) g (P=0.13; g=0.45). Under the experimental protocol employed, commercially-available form of dandelion ingested, dosing strategy, and cohort investigated, cumulative urine output was similar in the presence or absence of dandelion root powder being co-ingested with a large bolus of water, indicating a lack of support for the purported diuretic effect of dandelion. Future studies should investigate different time courses, dosing strategies, and sources of dandelion, as well as study designs with greater ecological validity for weight category sports, before definitive conclusions can be made.

KEYWORDS

dehydration; rapid weight loss; Taraxacum officinale; urine output;

ABBREVIATIONS

CON, control condition; CV, coefficient of variation; DAND, dandelion root condition; FFM, fat-free mass; RWL, rapid weight loss; SD, standard deviation; SEM, standard error of the mean; SWD, smallest worthwhile difference.

INTRODUCTION

In sports that have weight class restrictions such as combat sports, rowing, horse-racing, and weightlifting, athletes attempting to ‘make weight’ frequently practice short-term weight loss, termed acute or rapid weight loss (RWL), in the ~72 h before weigh-in (Burke et al., 2021; Reale et al., 2017b). RWL typically averages ~2% to 10% depending on the sport (Barley et al., 2018; Connor & Egan, 2019; Cox et al., 2025; Hillier et al., 2019; Nolan et al., 2020; Reale, Slater, & Burke, 2018). The most common methods of RWL focus on the short-term reduction of the contents of the gastrointestinal tract through a low residue diet, and on the acute reduction of total body water through low carbohydrate intake, fluid restriction, and increasing sweat losses through exercise and/or heat exposure (Barley et al., 2018; Connor & Egan, 2019; Cox et al., 2025; Hillier et al., 2019; Nolan et al., 2020; Reale, Slater, & Burke, 2018).

Another approach to reduce total body water is to increase urine output beyond the volume of fluids ingested in a given time period. An increase in urine output can be reliably achieved by diuretics, a class of compounds often used therapeutically to adjust the volume and composition of body fluids, or to eliminate excess of fluids from tissues (Cadwallader et al., 2010). Yet, pharmacological diuretics are banned in sports that adhere to the World Anti-Doping Authority code, because in addition to assisting with making weight, these compounds can mask the presence of prohibited substances by reducing their concentration in urine primarily by an increase in urine volume (Cadwallader et al., 2010). Consequently, athletes in weight category and aesthetic sports may consider legal herbal medicines with purported diuretic effects to support their weight-making efforts (Escalante et al., 2021; Reale et al., 2017a).

By one account almost two decades ago, there were more than 100 herbal extracts reporting potential diuretic effects (Wright et al., 2007), but few were supported with adequate results from human studies (Wright et al., 2007). One example with a claimed diuretic effect is dandelion extract, which is extracted from the root or leaves of the perennial flowering plant *Taraxacum officinale* of the Asteraceae family (González-Castejón et al., 2012; Tanasa Acretei et al., 2025). Dandelion has reportedly been used for centuries in Eastern medicine and phytotherapy for the treatment of liver, kidney, lung disorders, and diabetes, and has been associated with a range of anti-inflammatory, antimicrobial, antioxidant, and immunomodulatory properties (González-Castejón et al., 2012; Tanasa Acretei et al., 2025). However, empirical evidence for a diuretic effect of dandelion is scant. Studies in rodents have observed both positive (Rácz-Kotilla et al., 1974) and null (Hook et al., 1993; Tita et al., 1993) effects on urine output. The single human study performed to date provided three doses of a dandelion leaf extract, with each dose separated by 5 h, and observed an increase in the frequency of urination over the first 10 h, but no difference in cumulative urine output over a 24 h period compared to the control condition (Clare et al., 2009). Despite the absence of evidence to date for a diuretic effect of dandelion, consumption of dandelion tea has been reported as part of the contest preparation week of competitive natural bodybuilders (Chappell & Simper, 2018), and dandelion root is suggested as helpful for making weight by respected sources with tacit knowledge of the field (Lennon, 2014; Mirjavadi, 2011).

Therefore, to address this gap between evidence and practice, the present study investigated whether the ingestion of a commercially-available dandelion root powder acutely elicited a diuretic effect in physically-active young adults. Stated as a null hypothesis, we hypothesised that dandelion root powder would not result in an increase in cumulative urine output over a 4 h period after co-ingestion with water when compared to ingestion of water alone.

MATERIALS & METHODS

Participants

Physically-active, healthy young adults were recruited to participate in this study. Exclusion criteria included the use of prescription or over-the-counter medications, diuretic medication, or herbal supplements purported to be natural diuretics that could affect body fluid homeostasis; allergies or hypersensitivity to dandelion or related plants (e.g., ragweed); current adherence to a weight-loss diet; and current smokers or e-cigarette users. Additionally, female participants were required to be eumenorrheic or using hormonal contraception, whereas those who were pregnant or lactating were excluded. Equal efforts were undertaken to recruit male and female participants.

Of the 24 volunteers who were screened for participation, 18 were eligible but 2 withdrew before commencing the trial, and 6 were ineligible due to factors such as prescription medication use, anabolic-androgenic steroids use, a medically-confirmed menstrual disorder, irregular menstrual cycle, and adherence to an energy-deficit diet (Figure 1). Therefore, n=16 participants commenced the study, with one participant not returning to the laboratory after completing the first trial, and another participant's data being excluded because of non-compliance with the required pre-trial preparation, which resulted in a final sample size of n=14 (Figure 1). The sample was comprised of n=12 male and n=2 female participants (age, 25.5±4.7 y; height, 1.76±0.08 m; body mass, 79.7±14.5 kg; body mass index, 25.7±4.1 kg/m^2; body fat, 19.0±6.3%; fat-free mass (FFM), 64.1±9.8 kg; FFM index, 20.7±2.2 kg/m^2).

The study protocol was approved by the ANONYMISED Research Ethics Committee (permit: ANONYMISED), and was conducted in accordance with the Declaration of Helsinki, with the exception of preregistration in a trial database. Before commencing, participants provided written informed consent to participate after written and verbal explanation of the study procedures.

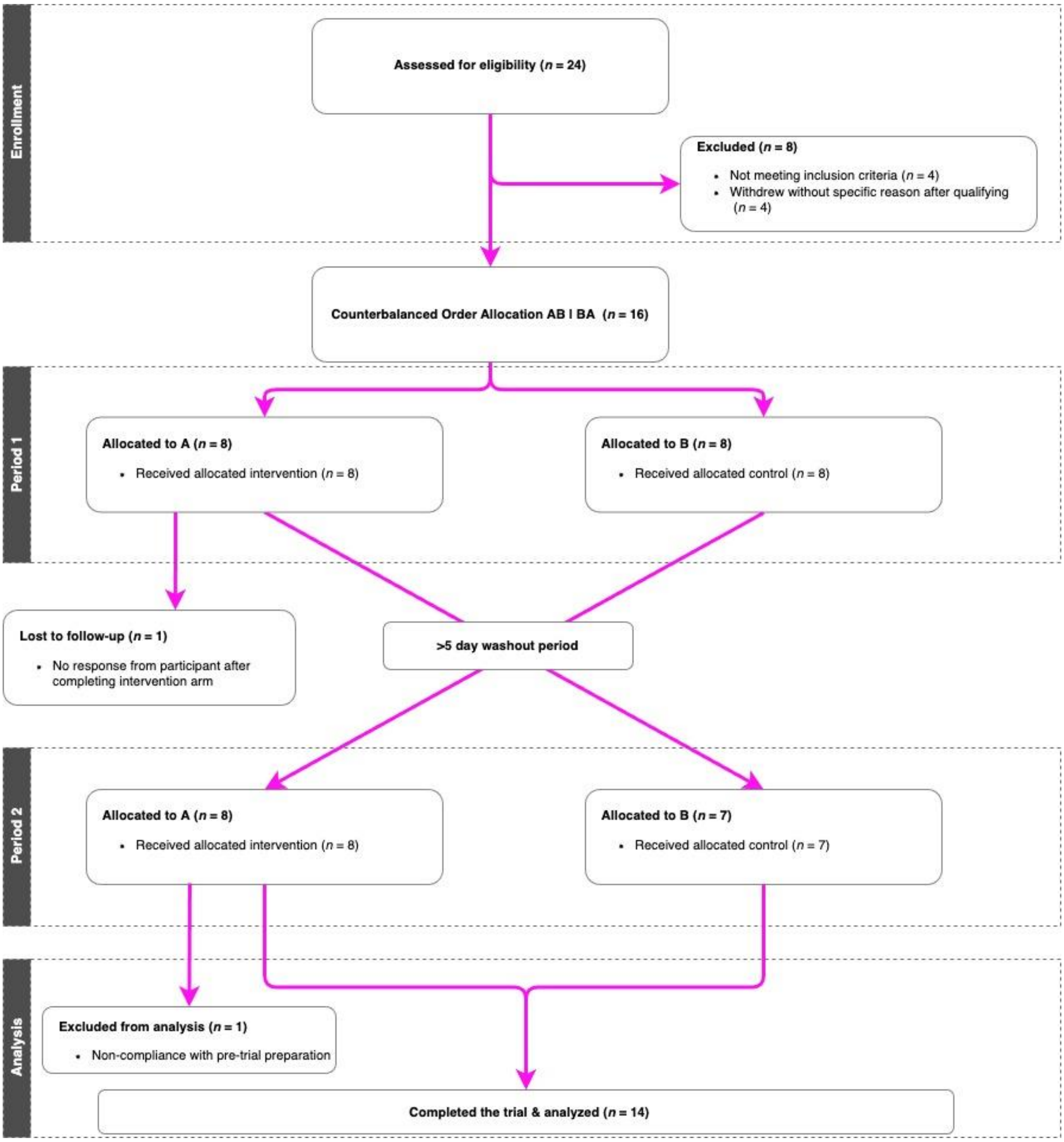

Figure 1. Participant flow chart

Study design

The main experimental trials were based on protocol of Maughan et al. (2016), which assessed the impact of consuming 1 L of various drinks on cumulative urine output over the following 4 h as an index of the impact of the ingestion of a given drink on hydration status and net fluid balance. The coefficient of variation (CV) as a measure of repeatability for the primary outcome of cumulative urine output (measured in g) was reported as 18% for this protocol (Maughan et al., 2016).

Participants visited the Metabolic Research Laboratory at ANONYMISED on two occasions, once during which they ingested still water as the control condition (CON), and once during which they ingested a commercially-available dandelion root powder in capsule form along with still water (DAND). Therefore, the study was open label. The study employed a crossover design, conducted in a counterbalanced order, whereby participants were allocated to trial arm using AB / BA design (minimising sequence effects).

A pre-trial standardisation protocol was employed for the 36 h period before both visits. The time between visits was no less than 3 days and no more than 7 days. To minimise the influence of circadian and diurnal variation on outcomes, visits 1 and 2 were conducted in the morning in the fasted state, and all commenced between 0830 and 0930. The two female participants were long-time (>4 y) levonorgestrel intrauterine device users (Kyleena™ and Mirena™), and thus the potential influence of the phase of the menstrual cycle was not accounted for. Trials were conducted in a temperature-controlled (20±1°C) laboratory. Height (to the nearest 0.01 m) was measured using a stadiometer (Model 213, SECA GmbH & Co. KG, Hamburg, Germany). Body mass (to the nearest 0.1 kg) and body composition (FFM, body fat) were measured using a foot-to-foot dual-frequency 4 electrode (6.25 kHz, 50 kHz) bioelectrical impedance analysis device (TIDC-360S; Tanita Corporation, Tokyo).

Dandelion root powder and compositional analysis

The source of dandelion for investigation was a commercially-available dandelion root powder (Dandelion Root; Solgar® Vitamin & Herb, Leonia, NJ USA) purchased from a local health store, and stored at room temperature. According to the manufacturer's product label, one capsule contained 328 mg of "raw dandelion root powder" and 52 mg of a 4:1 "dandelion root powdered extract". This 4:1 ratio would be equivalent to 208 mg of raw dandelion root based on current regulations (Monagas et al., 2022), although a certificate of analysis was not forthcoming from the manufacturer despite a number of requests. Thus, each capsule provided the equivalent of 536 mg of dandelion root powder, and with 4 capsules being ingested, these provided a total dose of ~2144 mg of dandelion root powder equivalent.

Total proximate compositional analysis of the commercially-available dandelion root powder was performed using the official Association of Official Analytical Chemists (AOAC) methods. Moisture content was determined according to AOAC method 925.10 (AOAC, 1925) using the TGM800 Thermogravimetric Moisture determinator (LECO, USA). Fat percentage was determined according to AOAC method 985.14 (AOAC, 1991) using the Oracle NMR Smart Trac Rapid Fat analyser (CEM Corporation, USA). Total protein content was determined based on the Dumas method according to AOAC method 992.15 (AOAC, 1992) using a LECO FP628 (LECO Corp, MI, USA) nitrogen analyser, with conversion factor of 6.25 employed for nitrogen. Inorganic ash content was determined according to AOAC method 936.07 (AOAC, 1936) using a Gallenkamp Muffle Furnace with pre-drying overnight at 550°C (Gallenkamp, UK). The total dietary fibre content, including insoluble and soluble dietary fibre, was determined according to AOAC method 991.43 (AOAC, 1994) (enzymatic-gravimetric method) using Ankom automated dietary fibre analyser (Ankom, USA), and corrected by protein and ash content. The composition of the dandelion root powder was calculated as: fibre, 20.9±0.6%; protein, 10.0±0.1%; fat, <1%; ash, 4.34±0.02%; and moisture, 8.3±0.1%.

Pre-trial standardisation

Beginning ~36 h before each visit, participants were asked to refrain from consuming alcoholic beverages. On the day before each visit, participants were asked to refrain from exercising after 1PM, refrain from consuming caffeine after 9PM, have their last meal before 10PM, and consume at least 2 L of still water (tap or bottled) throughout the course of the day. Meals were not provided, and there was no restriction on the types of foods participants could consume. However, participants were instructed to send images of all consumed food to the researchers via the WhatsApp Messenger platform (Meta Platforms, Inc, CA, USA). The images of dietary intake served as a reference for participants to replicate the same diet to the best of their ability before visit 2. Participants were also provided with a digital pre-trial standardisation checklist to support compliance with the instructions, and replication from visit 1 to visit 2.

On the morning of each visit, participants were asked to void upon waking, with the sample collected into urine collection container and brought to the laboratory. Sex-specific urine collection containers were used throughout the study (male: Warwick Male Urine Bottle with Lid and Handle, Medguard HealthCare Ltd, Ireland, SKU: UML1000; female: Urinal with Lid and Female Adaptor, Medguard HealthCare Ltd, Ireland, SKU: SD20980). Participants were asked to consume 500 mL still water (tap or bottled) over a 15 min period commencing 75 min before their scheduled arrival time at the laboratory in order to standardise hydration status at the start of each trial. Lastly, participants were instructed to avoid stressful situations and engage with minimal physical activity on their way to the laboratory. Compliance with these pre-trial standardisation instructions was confirmed verbally upon arrival at the laboratory for each visit.

Main experimental trials

Upon arrival to the laboratory, participants were asked again to void their bladder into a urine collection container. Hydration status was assessed by urine specific gravity using a hand-held, digital refractometer (PEN-Urine S. G., Atago Co., Ltd., Tokyo , Japan) in this urine sample, and the sample from the first void upon waking. Approximately 30 min later, participants began ingestion of 1 L of bottled still natural mineral water served at room temperature, which was divided into four boluses of 250 mL that were ingested at 7.5 min intervals. For DAND, the 4 capsules of dandelion root were ingested with the first bolus of water. Urine samples were collected and weighed at 1 h intervals for 4 h i.e. +1 h, +2 h, +3 h, and +4 h after completing ingestion of the 1 L of water. Cumulative urine output over 4 h was calculated as the sum of urine outputs from these 4 time points. No additional fluids were provided until the 4 h period concluded. During that period, a researcher was present at all times. Participants remained seated except for visiting the bathroom on each hour, and were permitted to engage in typical sedentary activities, such as reading or using electronic devices like laptops, tablets, and smartphones.

Sample size calculation

Our *a priori* sample size calculation considered the previous studies of Maughan et al. (2016) as the experimental protocol employed, and Clare et al. (2009) being the only prior study of the effect of dandelion on urine output in humans. In the results of Clare et al. (2009), 24 h urine output was expressed as mean±standard error of the mean (SEM) of 1874±221 mL for control condition, and 2148±212 mL for the dandelion condition (*P* value not stated, but reported as not significantly different). After converting the SEM to standard deviation (SD) based on the sample size of n=17 (906 and 869 mL, respectively), effect sizes were calculated as 0.69 and 0.97 when assuming the correlation between conditions of 0.90 or 0.95, respectively (G*Power 3) (Faul et al., 2007). Maughan et al. (2016) observed effect sizes ranging from 0.65 to 1.09 when detecting significant differences ($P<0.05$) between various drinks for their effects on urine output, albeit decreasing urine output in those conditions, and an effect size of 1.1 when observed the effect of alcohol ingestion to produce an increase in urine output over 4 h (Hobson & Maughan, 2010). Using an α value of 0.05 and a power (1-β) value of 0.8, and based on the primary outcome being difference in cumulative urine output over 4 h assessed by a paired samples t-test, these effect sizes resulted in a required sample size of between n=9 and n=21 (G*Power 3).

Statistical analysis

Statistical analysis was performed using GraphPad Prism v10.5 (GraphPad Software Inc, La Jolla, CA USA). Data are presented as mean±SD unless otherwise stated. The normality of data was assessed with the Shapiro-Wilk normality test, for which all data passed. A two-way (Time*Condition) repeated measures analysis of variance (ANOVA) was performed to assess differences in cumulative urine output on an hourly basis (time course analysis). Sphericity was not assumed, and the Greenhouse-Geiser correction was applied to this analysis. Between-condition comparisons for all other outcomes were performed using paired samples t-tests. Effect size was calculated as Hedges' *g*. The smallest worthwhile difference (SWD) for difference in cumulative urine output between conditions was calculated as 0.2 x the pooled SD (Hopkins, 2000). The threshold for statistical significance was set at $P<0.05$ for all tests.

RESULTS

Morning urine output before commencing ingestion of the 1 L of water was similar between conditions (CON, 370±230 g vs. DAND, 399±216 g; $P=0.48$; $g=0.13$). Urine specific gravity measured in the urine samples from the morning void (CON, 1.017±0.007 vs. DAND, 1.015±0.008; $P=0.32$; $g=0.27$), and before ingestion of the 1 L of water (CON, 1.011±0.005 vs. DAND, 1.010±0.008; $P=0.18$; $g=0.15$) were similar between conditions.

Cumulative urine output over 4 h after ingestion was 1164±244 g in CON and 1268±213 g in DAND (Figure 2A), with the mean difference (95% confidence interval) of 105 (-35 to 244) g (Figure 2B) indicating no statistically significant differences between conditions ($P=0.13$; $g=0.45$). No trial order effect was evident when comparing cumulative urine output between visit 1 (1232±242 g) and visit 2 (1199±227 g) regardless of experimental condition ($P=0.65$). To assess individual responses, the SWD was calculated as 48 g. Cumulative urine output was greater than SWD for n=4 participants in CON, and greater than SWD for n=9 participants in DAND (Figure 2B). Using a threshold of 219 g based on the reported CV of

18% for this protocol (Maughan et al., 2016), cumulative urine output was greater than the CV for n=3 participants in CON, and for n=5 participants in DAND (Figure 2B). The hourly time course of cumulative urine output is illustrated in Figure 3, where a main effect of Time was observed ($P<0.001$), but neither a Condition ($P=0.21$) nor a Time*Condition ($P=0.30$) interaction effect was observed.

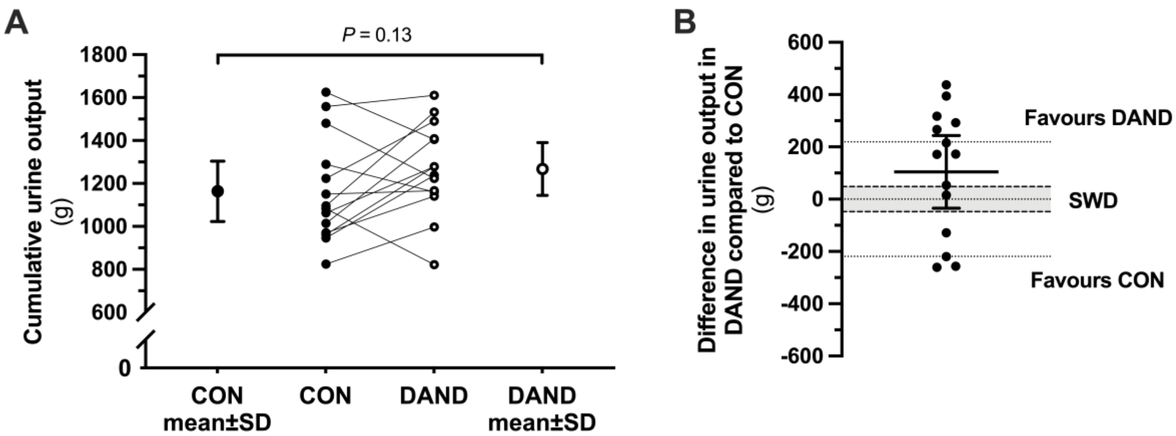

Figure 2. A) Cumulative urine output over 4 h (n=14) after ingestion of 1 L of water with (DAND) or without (CON) the ingestion of capsules providing ~2.1 g of dandelion root powder. Error bars represent standard deviation. **B)** Individual participant data illustrating the difference in cumulative urine output between CON and DAND. The solid line and error bars represent the mean difference and 95% confidence interval. The shaded grey area represents the smallest worthwhile difference between conditions. The upper and lower dotted lines represent a CV of 18% as previously reported for this method of assessing cumulative urine output over 4 h (Maughan et al., 2016).

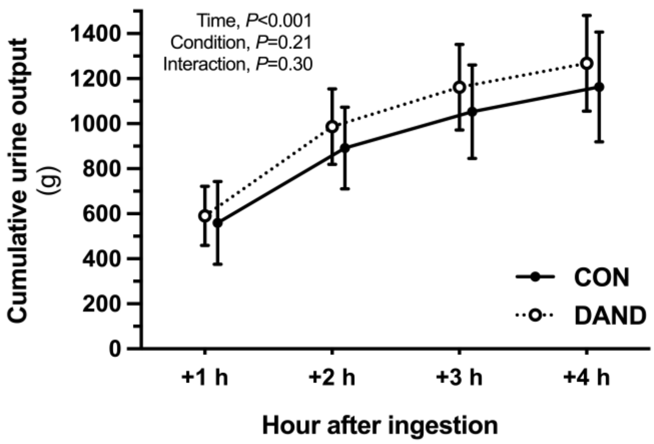

Figure 3. The hourly time course of cumulative urine output over 4 h after ingestion of 1 L of water with (DAND) or without (CON) the ingestion of capsules providing ~2.1 g of dandelion root powder. Data points are mean values (n=14) with error bars representing standard deviation.

DISCUSSION

The results of this study do not support the purported diuretic effect of dandelion, at least under the conditions investigated using a commercially-available dandelion root powder in this cohort of physically-active healthy young adults. Cumulative urine output over 4 h after the ingestion of 1 L of still water was similar in the presence or absence of dandelion root powder capsules being co-ingested.

Despite the historical association of dandelion with diuresis (González-Castejón et al., 2012; Tanasa Acretei et al., 2025; Wright et al., 2007), empirical research investigating the effect of dandelion as a diuretic is limited, with to our knowledge only four published articles investigating the effect directly (Clare et al., 2009; Hook et al., 1993; Rácz-Kotilla et al., 1974; Tita et al., 1993). The earliest study investigated the effect on urine output over 5 h in rats after administration of dandelion extracts from both the leaf and the root (Rácz-Kotilla et al., 1974). Dose-responsive diuretic effects were observed with both extracts, but the largest effect was observed with 4% concentration of the leaf extract, which produced a similar diuretic effect to 80 mg/kg of furosemide, a known pharmacological diuretic, by resulting in ~90% more urine being produced relative to the volume of fluid administered (Rácz-Kotilla et al., 1974). The high potassium content of dandelion was proposed as a potential mechanism for this effect, and of further note is that the potassium content of the leaf (4.51% w/w) was reported as greater than the root (2.45% w/w) (Hook et al., 1993). A second study, this time performed in mice, investigated extracts from dandelion root administered in different solvents as a means to explore the potential effects of different bioactive components (Hook et al., 1993). Many potentially bioactive compounds are present in dandelion extracts, including carotenoids, tocopherols, polyphenols, flavonoids, saponins, terpenes, coumarins, and phytosterols (González-Castejón et al., 2012; Tanasa Acretei et al., 2025). However, whereas furosemide (35 mg/kg) again produced a diuretic effect (~two-fold greater urine output), none of the five extracts or fractions of the dandelion root produced a significant diuretic effect over the 5 h period, despite some evidence of increases in sodium and potassium excretion (Hook et al., 1993).

The single human study performed to date studied the effects of a fresh leaf hydroethanolic extract of dandelion in a cohort of n=17 participants (Clare et al., 2009). In that design, the day before (Day -1) and day after (Day +1) the main trial served as the control conditions during which the volume of fluid consumed, and the frequency of urination and volume produced, was recorded. On the day of the main trial (Day 0), dandelion was provided as a total of three doses, each 5 h apart i.e. at 0800, 1300 and 1800. The frequency of urination increased from 8.0±0.8 and 8.1±1.1 on Days -1 and +1, respectively, to 9.0±0.9 (all mean±SEM) on the day of the dandelion intervention, with the effect manifested as differences in the first 10 h i.e. after the first and second doses. An increase in excretion ratio (the ratio of urine output to the volume of fluid ingested) was also noted, but despite these significant differences in response to dandelion leaf extract, cumulative urine output over 24 h was not statistically different on all three days (Clare et al., 2009). A major confounder was that fluid intake was *ad libitum* on each day such that differences in urine output also reflected differences in fluid intake on each day i.e. the fluid intakes and urine outputs were Day -1, 2125±188 mL and 1874±221 mL; Day 0, 2313±249 mL and 2148±212 mL; and Day +1, 1998±153 mL and 1988±205 mL (all mean±SEM) (Clare et al., 2009). Another limitation was that the study was conducted remotely and unsupervised, with consequently the dandelion leaf extract being self-administered, and the fluid intake and urine output being self-reported.

The present study attempted to address some of limitations of that work by conducting a laboratory-based study under full supervision, employing a rigorous pre-trial standardization protocol, and by providing a known quantity of water in a fixed timeframe using an established protocol (Maughan et al., 2016). Yet, despite these strengths and increment in knowledge provided by the data, the study is not without limitations. First, as an open label study, bias could be introduced on behalf of the investigator or participant, which for the latter would manifest as a placebo effect increasing the likelihood of between-group differences. However, in the domain of urology, objective measures (e.g. urine volume, urination frequency) are frequently observed to be less influenced by the placebo effect than subjective measures (Mostafaei et al., 2022), and nor was there a between-group difference observed in the present study. Second, the bolus ingestion of fluid can produce a marked diuresis compared to a more ecologically-valid “metered” pattern of ingestion (Jones et al., 2010), such that any diuretic effect of dandelion may have been masked by the larger impact of this bolus intake of water on urine output. This bolus ingestion protocol has been previously demonstrated to detect the diuretic effect (~14% increase in urine output) of alcoholic beer (4% alcohol v/v) compared to non-alcoholic beer (Hobson & Maughan, 2010), but it is possible that more subtle diuretic effects would not be detected using this protocol. Lastly, choosing a dosing strategy is a challenging aspect in a field where such little work has been performed. The dose eliciting the greatest diuretic effect in rats (Rácz-Kotilla et al., 1974) has been calculated as a human equivalent dose of 640 mg/kg (Clare et al., 2009). The dose in the present study was approximately 28±6 mg/kg. This dose (4 capsules; ~2144 mg) was based upon consideration of the manufacturer’s recommendation of 1 to 3 capsules consumed daily with meals, and the recommendation from applied practice in the weight-making process of 3 g per day, split over three equal doses (Lennon, 2014). However, the dose of dandelion and the quantity of water were provided as absolute quantities rather than on a per kg of body mass basis, which may have introduced between-subject variations in the response to the protocol.

These limitations and other chosen features of the present study design are informative for future studies. Given the caveat above in relation to the dose employed, investigation of escalating doses of dandelion is warranted. Measuring biomarkers in blood or urine that are related to fluid balance or bioactives potentially present in dandelion would be valuable to provide insight into the mechanisms of diuresis, if an effect is observed. A related issue is the source of dandelion ingested, which in this study was a commercially-available dandelion root powder, but other forms are commercially-available including leaf powder, teas, liquid extracts, and tinctures. Each of these sources can vary in the concentration of dandelion extract that is stated on the label as being present, and often have different recommendations ranging from a single dose up to several doses daily. While the present study investigated the potential for diuretic effects of a single dose over a fixed time period of 4 hours after ingestion, it is possible that effects could be observed over a longer time frame or with repeated ingestion throughout a day. That consideration is salient in the context of sports that have weight class restrictions in which athletes are practicing RWL over ~72 h before weigh-in (Burke et al., 2021; Reale et al., 2017b). While a short-term effect on urine output in the few hours prior to weigh-in would be one valuable feature of an herbal diuretic, these athletes may consider a small diuretic effect over several days prior to weigh-in to also be of value. Investigating this possibility would have greater ecological validity for weight category sports by investigating the potential effects on athletes in a prolonged hypohydrated state, rather than co-ingestion with a large bolus of water while already in a euhydrated state as employed in the present study.

In applied practice, the use of dandelion for weight-making and contest preparation is likely to remain of interest (Chappell & Simper, 2018; Escalante et al., 2021; Reale et al., 2017a), given that dandelion is readily-available over-the-counter, and purported as an alternative to pharmacological diuretics that are prohibited for use in many sports (Cadwallader et al., 2010). Increasing urine output remains an important strategy in the RWL process. One example is the method of water loading, which involves several days of consumption of large fluid volumes (e.g. 100 mL/kg) prior to a period of fluid restriction (Reale, Slater, Dunican, et al., 2018). Compared to typical daily water intake, water loading resulted in greater urine output during the fluid restriction period, and a larger reduction in body mass (3.2% vs. 2.4%) during a 5 day RWL intervention (Reale, Slater, Dunican, et al., 2018). Although those are numerically small differences, such magnitudes are of high importance in practice because weight-making in a weight category sport is based on a fixed threshold that defines the success or failure of making weight (Burke et al., 2021). Therefore, another important consideration in providing recommendations for supplement use is understanding the inter-individual response in a specific outcome (Burke, 2017). To do so, the intrinsic day-to-day variability in a measure must be considered, such as defining the CV for an outcome when a test is repeated. For the experimental protocol employed, the %CV has previously been reported as 18% (Maughan et al., 2016), which equates to 219 g in the present study. Applying that threshold to these data, cumulative urine output was greater than the CV for n=5 participants in DAND, which suggests that approximately 1/3 of the cohort observed a diuretic effect at an individual level. This positive interpretation should also be countered by the observation that for n=3 participants cumulative urine output was greater than the CV in CON, which could be translated as an *anti*-diuretic effect of dandelion in 1/5 of the cohort. Therefore, in applied practice, athletes and practitioners could explore efficacy at an individual level by following good practices in case study and n-of-1 experimental designs (Halperin, 2018; Payne et al., 2024).

In conclusion, under the conditions investigated in terms of experimental protocol, form of dandelion ingested, dosing strategy, and participant cohort, cumulative urine output was similar in the presence or absence of ~2.1 g of dandelion root powder being ingested with 1 L of still water. Therefore, the results of the present study do not support the purported diuretic effect of dandelion. Given the scarcity of empirical studies to date, but with the apparent historical and practical use of dandelion as a diuretic, future studies should investigate different time courses, dosing strategies, and sources of dandelion, as well as study designs with greater ecological validity for weight category sports, before definitive conclusions can be made.

REFERENCES

AOAC. (1925). *Association of Official Analytical Chemists (AOAC) official method 925.10, Solids (total) and loss on drying (moisture) in flour. Air oven method.* AOAC International. http://www.aoacofficialmethod.org/index.php?main_page=product_info&cPath=1&products_id=239

AOAC. (1936). *Association of Official Analytical Chemists (AOAC) official method 936.07, ash of flour. Magnesium acetate method.* AOAC International. http://www.aoacofficialmethod.org/index.php?main_page=product_info&products_id=2338

AOAC. (1991). *Association of Official Analytical Chemists (AOAC) official method 985.14, Fat (crude) in Meat and Poultry products – Rapid Microwave Drying Method.* AOAC International. https://www.aoacofficialmethod.org/index.php?main_page=product_info&cPath=1&products_id=2315

AOAC. (1992). *Association of Official Analytical Chemists (AOAC) official method 992.15, Crude protein in meat and meat products including pet foods. Combustion method. .* AOAC International. https://www.aoacofficialmethod.org/index.php?main_page=product_info&cPath=1&products_id=383

AOAC. (1994). *Association of Official Analytical Chemists (AOAC) official method, 991.43, Total soluble and insoluble dietary fibre. Enzymatic- gravimetric method, MES-TRIS buffer.* AOAC International. https://www.aoacofficialmethod.org/index.php?main_page=product_info&cPath=1&products_id=1183

Barley, O. R., Chapman, D. W., & Abbiss, C. R. (2018). Weight Loss Strategies in Combat Sports and Concerning Habits in Mixed Martial Arts. *Int J Sports Physiol Perform*, *13*(7), 933-939. https://doi.org/10.1123/ijspp.2017-0715

Burke, L. M. (2017). Practical Issues in Evidence-Based Use of Performance Supplements: Supplement Interactions, Repeated Use and Individual Responses. *Sports Med*, *47*(Suppl 1), 79-100. https://doi.org/10.1007/s40279-017-0687-1

Burke, L. M., Slater, G. J., Matthews, J. J., Langan-Evans, C., & Horswill, C. A. (2021). ACSM Expert Consensus Statement on Weight Loss in Weight-Category Sports. *Curr Sports Med Rep*, *20*(4), 199-217. https://doi.org/10.1249/jsr.0000000000000831

Cadwallader, A. B., de la Torre, X., Tieri, A., & Botrè, F. (2010). The abuse of diuretics as performance-enhancing drugs and masking agents in sport doping: pharmacology, toxicology and analysis. *Br J Pharmacol*, *161*(1), 1-16. https://doi.org/10.1111/j.1476-5381.2010.00789.x

Chappell, A. J., & Simper, T. N. (2018). Nutritional Peak Week and Competition Day Strategies of Competitive Natural Bodybuilders. *Sports (Basel)*, *6*(4). https://doi.org/10.3390/sports6040126

Clare, B. A., Conroy, R. S., & Spelman, K. (2009). The diuretic effect in human subjects of an extract of Taraxacum officinale folium over a single day. *J Altern Complement Med*, *15*(8), 929-934. https://doi.org/10.1089/acm.2008.0152

Connor, J., & Egan, B. (2019). Prevalence, Magnitude and Methods of Rapid Weight Loss Reported by Male Mixed Martial Arts Athletes in Ireland. *Sports (Basel)*, *7*(9), 206. https://doi.org/10.3390/sports7090206

Cox, A. M., Langan-Evans, C., Jenkins, D., Reale, R., Pelly, F., & Slater, G. J. (2025). Body Mass Management Practices of Olympic Weightlifting Athletes. *Int J Sport Nutr Exerc Metab*, *35*(1), 67-75. https://doi.org/10.1123/ijsnem.2024-0064

Escalante, G., Stevenson, S. W., Barakat, C., Aragon, A. A., & Schoenfeld, B. J. (2021). Peak week recommendations for bodybuilders: an evidence based approach. *BMC Sports Sci Med Rehabil*, *13*(1), 68. https://doi.org/10.1186/s13102-021-00296-y

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Method*, *39*(2), 175-191. https://doi.org/10.3758/bf03193146

González-Castejón, M., Visioli, F., & Rodriguez-Casado, A. (2012). Diverse biological activities of dandelion. *Nutr Rev*, *70*(9), 534-547. https://doi.org/10.1111/j.1753-4887.2012.00509.x

Halperin, I. (2018). Case Studies in Exercise and Sport Sciences: A Powerful Tool to Bridge the Science-Practice Gap. *Int J Sports Physiol Perform*, *13*(6), 824-825. https://doi.org/10.1123/ijspp.2018-0185

Hillier, M., Sutton, L., James, L., Mojtahedi, D., Keay, N., & Hind, K. (2019). High Prevalence and Magnitude of Rapid Weight Loss in Mixed Martial Arts Athletes. *Int J Sport Nutr Exerc Metab*, *29*(5), 512-517. https://doi.org/10.1123/ijsnem.2018-0393

Hobson, R. M., & Maughan, R. J. (2010). Hydration status and the diuretic action of a small dose of alcohol. *Alcohol Alcohol*, *45*(4), 366-373. https://doi.org/10.1093/alcalc/agq029

Hook, I., A., M., & and Henman, M. (1993). Evaluation of Dandelion for Diuretic Activity and Variation in Potassium Content. *Int J Pharmacogn*, *31*(1), 29-34. https://doi.org/10.3109/13880209309082914

Hopkins, W. G. (2000). Measures of reliability in sports medicine and science. *Sports Med*, *30*(1), 1-15.

Jones, E. J., Bishop, P. A., Green, J. M., & Richardson, M. T. (2010). Effects of metered versus bolus water consumption on urine production and rehydration. *Int J Sport Nutr Exerc Metab*, *20*(2), 139-144. https://doi.org/10.1123/ijsnem.20.2.139

Lennon, D. (2014). *Making the Cut, Part IV: How to Cut Weight for a Fight (Properly!)*. Retrieved 28/05/2025 from https://sigmanutrition.com/making-cut-part-iv-weight-cutting/

Maughan, R. J., Watson, P., Cordery, P. A., Walsh, N. P., Oliver, S. J., Dolci, A., Rodriguez-Sanchez, N., & Galloway, S. D. (2016). A randomized trial to assess the potential of different beverages to affect hydration status: development of a beverage hydration index. *Am J Clin Nutr*, *103*(3), 717-723. https://doi.org/10.3945/ajcn.115.114769

Mirjavadi, S. (2011). *Meeting the Scale: The Art of Making Weight*. Retrieved 28/05/2025 from https://www.elitefts.com/education/training/meeting-the-scale-the-art-of-making-weight-edited/

Monagas, M., Brendler, T., Brinckmann, J., Dentali, S., Gafner, S., Giancaspro, G., Johnson, H., Kababick, J., Ma, C., Oketch-Rabah, H., Pais, P., Sarma, N., & Marles, R. (2022). Understanding plant to extract ratios in botanical extracts. *Front Pharmacol*, *13*, 981978. https://doi.org/10.3389/fphar.2022.981978

Mostafaei, H., Jilch, S., Carlin, G.L., Mori, K., Quhal, F., Pradere, B., Laukhtina, E., Schuettfort, V. M., Aydh, A., Sari Motlagh, R., Roehrborn, C. G., Shariat, S. F., & Hajebrahimi, S. (2022). The placebo and nocebo effects in functional urology. *Nat Rev Urol, 19*(3), 171-189. https://doi.org/10.1038/s41585-021-00545-2

Nolan, D., Lynch, A. E., & Egan, B. (2020). Self-Reported Prevalence, Magnitude, and Methods of Rapid Weight Loss in Male and Female Competitive Powerlifters. *J Strength Cond Res, 6*(2),405-410. https://doi.org/10.1519/jsc.0000000000003488

Payne, E., Vieira, R., & de Roos, B. (2024). Novel study designs and modelling approaches in nutrition research: application of advanced statistical modelling approaches and N-of-1 study designs. *Proc Nutr Soc*, 1-6. https://doi.org/10.1017/s0029665124007602

Rácz-Kotilla, E., Rácz, G., & Solomon, A. (1974). The action of Taraxacum officinale extracts on the body weight and diuresis of laboratory animals. *Planta Medica*, *26*(3), 212-217. https://doi.org/10.1055/s-0028-1099379

Reale, R., Slater, G., & Burke, L. M. (2017a). Acute-Weight-Loss Strategies for Combat Sports and Applications to Olympic Success. *Int J Sports Physiol Perform*, *12*(2), 142-151. https://doi.org/10.1123/ijspp.2016-0211

Reale, R., Slater, G., & Burke, L. M. (2017b). Individualised dietary strategies for Olympic combat sports: Acute weight loss, recovery and competition nutrition. *Eur J Sport Sci*, *17*(6), 727-740. https://doi.org/10.1080/17461391.2017.1297489

Reale, R., Slater, G., & Burke, L. M. (2018). Weight Management Practices of Australian Olympic Combat Sport Athletes. *Int J Sports Physiol Perform*, *13*(4), 459-466. https://doi.org/10.1123/ijspp.2016-0553

Reale, R., Slater, G., Dunican, I. C., Cox, G. R., & Burke, L. M. (2018). The Effect of Water Loading on Acute Weight Loss Following Fluid Restriction in Combat Sports Athletes. *Int J Sport Nutr Exerc Metab*, *28*(6), 565-573. https://doi.org/10.1123/ijsnem.2017-0183

Tanasa Acretei, M. V., Negreanu-Pirjol, T., Olariu, L., Negreanu-Pirjol, B. S., Lepadatu, A. C., Anghel Cireasa, L., & Rosoiu, N. (2025). Bioactive Compounds from Vegetal Organs of Taraxacum Species (Dandelion) with Biomedical Applications: A Review. *Int J Mol Sci*, *26*(2). https://doi.org/10.3390/ijms26020450

Tita, B., Bello, U., Faccendini, P., Bartolini, R., & Bolle, P. (1993). Taraxacum officinale W.: pharmacological effect of ethanol extract. *Pharmacol. Res*, *27*(Suppl 1), 23-24.

Wright, C. I., Van-Buren, L., Kroner, C. I., & Koning, M. M. (2007). Herbal medicines as diuretics: a review of the scientific evidence. *J Ethnopharmacol*, *114*(1), 1-31. https://doi.org/10.1016/j.jep.2007.07.023