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Common mistakes when using plant names and how to avoid them

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How appropriate use of nomenclature achieves scientific integrity and ensures your research will be found

When publishing their research on natural products and traditional preparations from plants, authors need to use scientific plant names appropriately and unambiguously - both to ensure the scientific integrity of their research and to facilitate citation and recognition of their work. Whilst many papers follow best practice, including some in this issue [page 623, page 631], many others would have benefitted from improvements in their research procedures or the presentation of their results. Earlier authors have quantified the problems with plant names used in medicinal plant and nutritional science publications [1,2]. Here we highlight the most common mistakes that are made, giving a few examples, and offer advice on how best to approach the use of scientific plant names, in order that these mistakes can be avoided in future.

For clarity when reading this paper, scientific plant names are only those names which have been formally published according to the International Code of Nomenclature [3]; they are also often known as botanical or Latin names.

Failing to use scientific names

Common names for plants are part of our everyday language but are open to alternative interpretations. A common name can mean different things to different people (communities, professions, languages) in different geographic locations and their use can change over time.

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‘Ginseng’, for example, is associated with herbal substances derived from at least twelve different species from six different genera [4].

Pharmaceutical names, even though Latinised, are similarly under no formal control and are not ‘scientific’. They can refer to more than one species within a single monograph and the same pharmaceutical name can be used in different pharmacopoeias to refer to substances derived from different plant species. For example, the pharmaceutical name ‘Cimicifugae Rhizoma’ is used in the Chinese Pharmacopoeia [5] for a drug that can be sourced from one or more of three species of *Actaea* (syn. *Cimicifuga*). To ensure scientific accuracy, enable their work to be verified by others and for consistent drug formulation during their research, researchers would need to specify and use only one of these alternative sources. In addition, the same pharmaceutical name ‘Cimicifugae Rhizoma’ is used in the European Pharmacopoeia [6] for a drug sourced from only a single species of *Actaea*, but one that is completely different to the three species defined in the Chinese Pharmacopoeia, and with different medicinal uses. Use of such ambiguous names in research publications therefore gives readers no guarantee of the actual identity of the plant material studied. It also has implications for review articles which attempt to present conclusions based on published research whose source material is potentially different or inconsistent.

Botanical nomenclature is scientific not because it uses Latin but because formal publication of a scientific plant name includes the association of that name with a physical reference point (a herbarium ‘type’ specimen) which defines the meaning of that name for all time [3]. They further benefit from being international, used in all countries and disciplines, which will facilitate a paper being found by people working in different domains or speaking different languages. In contrast to the common and pharmaceutical names discussed above, inclusion of the scientific names of ingredients is necessary if not sufficient for, identification of ingredients to the species level. For original research (rather than reviews), scientific names should be backed up by a reference to where specimens of the plants studied in that article are stored, and identification of those specimens should be by a named expert.

Using scientific names, however, is not straight forward and poses a number of problems for researchers, which will now be outlined.

Misspelling scientific names

When describing the effects of the herbal drug Catuama on isolated rabbit heart, the authors refer to one of the ingredients as ‘*Zinziber officinalis*’, which is a misspelling for the genus name *Zingiber* [7]. Whilst a human reader may understand the authors’ intention, computer searches for articles about “Zingiber” would fail to locate this article. In papers where there are several misspellings some editors or readers may be tempted to question the overall merit of the paper as a result of such small errors. These papers are often rejected during the review process, but some do make it through to publication, potentially affecting the reputation of the authors, and reducing the likelihood that their research will be discovered.

Missing or Incorrect author names

Researchers are often unaware that the author of a scientific plant name is an integral part of that name and necessary to avoid ambiguity. Unfortunately in about 5% of cases the Latin binomial (genus and species) may have been published more than once by different botanist, and these alternative *homonyms* may potentially refer to more than one plant. For example, *Piper angustifolium* Lam. is the accepted name for a plant used medicinally in Brazil [4]. The same binomial was also later published by two botanists, Ruiz and Pavon, for a separate species which currently has the accepted name *P. aduncum* L.; *P. angustifolium* Ruiz & Pavon being one of its synonyms. The U.S. Homeopathic Pharmacopoeia [8] treats *P. angustifolium* Ruiz & Pavon as though it is an accepted name for one of its substances. Because of the common name that the Pharmacopoeia associates with that substance, Matico, we can be fairly confident that it is intended to refer to *P. aduncum* L., and was not miss-citing the author for *P. angustifolium* L. Any publication referring simply to *Piper angustifolium* without the author, however, would be ambiguous. One potential consequence of failing to cite an author of a scientific name is that research results may be attributed to the wrong species in error.

Being unaware of synonymy

Using correctly spelled scientific names within an article is necessary for, but not sufficient to ensure its scientific integrity. There are more than one million formally published scientific names for between 350,000 and 400,000 plant species. Thus each plant has multiple names (synonyms). Being unaware that two scientific names are synonyms for the same plant will cause authors difficulty. The consequences include:

Your research isn't novel – authors may fail to find research already published about that species under one of its alternative names. Manuscripts unintentionally repeating past research add little to science and may be rejected for publication.

You publish contradictory information - a single plant can be included in a manuscript under more than one name, with the potential for information to be contradictory, statistical analyses to be skewed or the author failing to see appropriate links between their results.

Using older names or an out of date taxonomy: the scientific names of plants change because additional specimens become available for study, and new molecular and chemical data requires taxonomists to review past species definitions and re-evaluate which species are most closely related. A common cause for a change in the name of a species is the move of a species from one genus to another. There are c. 4,000 such changes published each year [1].

Although this is both frustrating and confusing for people, such taxonomic changes do serve a scientific purpose and, for example, enable chemists to predict which species will share a particular chemical pathway. It is understandable that authors may use scientific plant names that are no longer the currently botanically accepted name of that species. Nevertheless this has consequences including failure of bibliographic searches to find your article i.e. if your article uses an older name then

it will only be retrieved when those undertaking bibliographic searches think to search using all possible names for that plant.

Ali-Shtayeh et al. [9] followed best practice when designing their investigation of the herbal preparations used by patients suffering from cancer in Palestine. They listed 59 species of plant used by at least 3 patients, and appropriately included the full binomial with author, plant family, common name in English and Arabic. Their approach would have been improved, however, had they used more current taxonomy in places, for example, *Origanum syriacum* L. rather than *Majorana syriaca* (L.) Rafin. and *Camellia sinensis* (L.) Sweet rather than *C. thea* Link. Since plant names change, it is inevitable that older papers will use outdated taxonomy and older names. *Camellia sinensis*, however, has been used by the majority of scientists for some time and it is unlikely that many would include *Camellia thea* in their search for papers. As a result this paper risks being underused and cited less frequently by other researchers.

Failing to use taxonomic references appropriately

Multiple botanical references exist online and in print to help researchers to check plant names. Authors need to be aware, however, that these reference sources vary in their purpose (not always clear to users), their scope and their degree of currency or maintenance (many using old data copies from one or more of the other references) and as a result even those with similar goals can give conflicting opinions. Each reference has limitations: none is perfect. Given this context it is not surprising that manuscript authors may choose inappropriate references to check their names, misinterpret the information presented by that reference or rely on out dated opinions or taxonomies. The International Plant Name Index (IPNI) [10], for example, serves as the default (standard) registry or catalogue of all published scientific names and as such includes the two alternative homonyms for *Piper angustifolium* mentioned above, plus an additional two potential homonyms. IPNI does not, however, indicate which names are synonyms of which, or which of the four homonyms in this case has priority and use of an inappropriate homonym will confuse and potentially mislead readers.

Neither does IPNI provide a consistent plant family classification since the family cited for any particular name will be that family definition which was current when the name was published, however long ago that was. Authors lacking botanical training may include these family names without question which can result in a manuscript containing inconsistencies, such as Lamiaceae/ Labiatae, Asteraceae/ Compositae, or Fabaceae/ Leguminosae/ Papilionaceae/ Mimosaceae/ Caesalpiniaceae [11].

Editors of Journals that are aware of these issues usually provide guidelines as part of their general instructions to authors. Such guidelines can include how authors should format and validate the plant names that they use, and these undoubtedly help to establish house rules. What is currently lacking is a consistent set of comprehensive guidelines across different journals. The lack of a consistent and scientifically rigorous use of plant names across natural product research continues to generate unnecessary inconsistency within the

literature and to cause severe difficulties subsequently for readers looking to locate, interpret and analyse relevant articles.

Author Guidelines

As a step towards a more consistent approach to plant names used in scientific publications, we recommend that journal guidelines include specific requirements.

These requirements can address some of the problems with both identification of plant material and the plant names used.

1. Voucher specimens: Representative voucher specimens should be made for all plants in the study, whether field collected or bought plant material such as crude drugs. Such vouchers should be accompanied by full collection details for field collected material, and include supplier details if bought. Where possible, they should be housed in a publicly accessible herbarium that will enable the specimens to be loaned to other researchers.
2. Identification: Ensure that the voucher specimens are identified by experts for the family, genus, or region and include the name and affiliation of each expert in the manuscript. Experts providing significant contributions to the research could also be acknowledged as authors.
3. Naming:
 - a. Non-scientific names: A locally or globally significant common, drug or pharmaceutical (pharmacopoeia) name, as appropriate to the subject, can make the article more accessible but should not be the only name used for each plant.
 - b. Scientific names: Include the full scientific name of each plant, e.g. *Matricaria chamomilla* L. The genus, species and any variety or subspecies name should be italicised; the author, 'var.' and 'subsp.' are not. The genus name must be given in full at least the first time that a name is mentioned in the manuscript, however, it can subsequently be abbreviated to the first letter, e.g. *M. chamomilla*, if this will not reduce the clarity of the manuscript. The author of a scientific plant name should be cited at least once and preferably the first time that the name is mentioned in the manuscript and in any table listing the plants studied. The most up to date scientific name should be used for each plant as determined by using the following resources in sequence, only moving on to the next one if the name being checked is not found: 1) Kew's Medicinal Plant Names Services portal (MPNS); 2) World Checklist of Selected Plant Families (WCSP); 3) The Plant List (TPL) (see below for further details). For most medicinal plants it will only be necessary to check the name in the MPNS portal. The date that the resource was accessed should be included with its citation in the reference list. Where the scientific name used in the flora for the region, or in relevant regulations, is different to the globally accepted name, the

regional or regulatory name should also be included as a synonym in the manuscript, preferably in brackets following the accepted name, e.g. *Matricaria chamomilla* L. (syn. *Matricaria recutita* L.).

Plant taxonomic resources

- 1) Kew's Medicinal Plant Names Services portal: follows the taxonomy recorded in the World Checklist (WCSP) both for families which have been published on that website and for medicinal plants from families still under development (which are otherwise inaccessible outside Kew). MPNS also includes all non-scientific names used in medicinal references (including all major pharmacopoeias) and provides external links which enable users to search external websites, such as NCBI, using the accepted scientific name and all its synonyms simultaneously. New versions of the MPNS Resource are released every 3 months to include additional medicinal references and reflect changes in Kew's taxonomy [access via link on <http://www.kew.org/mpns>].
- 2) World Checklist of Selected Plant Families (WCSP): the most up to date, actively curated taxonomy database, which is peer-reviewed by over 120 collaborators worldwide. It provides taxonomy and distributions for approximately 50% of plant families and is refreshed daily [<http://apps.kew.org/wcsp/home.do>]. Families are added to the WCSP website from the unpublished records as compilation of those families is completed and the family account undergoes peer-review. The MPNS project has been working to bring the taxonomy for all medicinal plants up to the same high standard as Kew's published WCSP records.
- 3) The Plant List (TPL): was built in collaboration with the Missouri Botanical Garden and other systematists worldwide. It is a working list of all known plant species and is comprehensive for all species of vascular plants and bryophytes (mosses and liverworts). Though complete, TPL is a static list that was built from data sets, including WCSP, supplied before August 2012, and thus does not reflect subsequent additions and improvements to these data sets [<http://www.theplantlist.org/>].

As a result of the above issues raised by Kew's Medical Plant Names Services, EuJIM has begun discussions about how to best tackle these issues so that the quality of accepted submissions will improve. A reporting checklist for those authors submitting articles which report herbal products will be located on the website and will be required on all submissions in the near future.

The content of this issue of EuJIM

This issue of EuJIM has two Special Sections '*Herbs and Health*' and '*Relaxation and Sleep*'. The section '*Herbs and Health*' described below consists of 14 articles (2 evidence summaries page 619, page 621, 2 systematic reviews (page 602, page 609), 9 original articles (pages 623, 631, 638, 645, 654, 661, 670, 676, 683) and 1 study protocol) (page 688).

The section '*Herbs and Health*' includes papers on the use of natural products for a variety of health issues including; diabetes, respiratory infection, cancer, osteoarthritis, dyslipidaemia, pregnancy and antibiotic resistance. For example, interest is currently growing regarding the use of Mulberry. A systematic review assesses the safety and efficacy of mulberry leaf extract against hyperglycemia and hyperlipidemia in patients with type 2 diabetes (page 602). Only 3 poor quality trials were identified which was insufficient to determine whether mulberry leaf extract is helpful for the management of patients with type 2 diabetes. The second systematic review and meta-analysis of 26 studies considers the use of Qingkailing injection for acute upper respiratory tract infections and similarly reports poor methodological quality (page 609). The Cochrane summary of evidence on *Ganoderma lucidum* (Reishi mushroom) of 5 studies with 373 people similarly reports poor quality (page 619). The *DynaMed Plus* summary looks at 5 randomized trials (n=757) comparing ginger vs. placebo for osteoarthritis. They conclude that there is moderate quality, based on the small number of participants and inadequate intention to treat. This is why it is now imperative for all researchers to improve their quality of reporting so that peers can understand what herbal products are actually being used. This will in turn improve the quality of systematic reviews. Two papers in particular have been highlighted by Kew as exhibiting good practice (page 623, page 631). However, this editorial also highlights the need to ensure that journals become more mindful in what they publish.

Other papers in this special section look at; *Antrodia cinnamomea* mycelium for mild hypertension (page 654), Pomegranate for improving cardiovascular risk factors in obese women with dyslipidemia (page 676) and a grape seed, Indian gooseberry, turmeric and fenugreek formulation to control advanced type 2 diabetes mellitus (page 645). The potential for integrating herbs into conventional western medicine is illustrated by two articles, one investigating 2 *Psidium* species potentiating the effect of antibiotics against Gram-positive and Gram-negative bacteria, and the other on antibacterial synergism of *Echeveria subrigida* with commercial antibiotics (page 638). The general population's perceptions and attitudes on herbs and health is illustrated in a population study from Iran together with a need to increase public awareness (page 661). A retrospective analysis on the use of herbal medicine on pregnancy outcomes suggests that pregnancy and live birth rate was improved for infertile women using Korean herbal treatment (page 670). The final paper in this section is a protocol for trialling a Chinese herbal formula for Postprandial Distress Syndrome (page 688).

The Special Section on '*Relaxation and Sleep*' highlights the various therapeutic benefits of exercise which offers the opportunity to increase fitness, promote relaxation as well as helping to improve sleep. It consists of 3 Systematic reviews and 10 original research articles. For people with a long-term or chronic condition this may be problematic when trying to identify and provide a suitable activity. The systematic review reported here (9 trials) failed to demonstrate that traditional Chinese exercise improved cancer related fatigue (CRF) (page 707). There were however some indications that at short term follow up, CRF improved but there was heterogeneity and methodological limitations. In a case series of stroke patients using individually tailor made virtual reality programmes for home management demonstrated significant improvements for upper motor functions after using the intervention and patients expressed high satisfaction (page 731). In a second small pilot

study with older adults with chronic stroke in community settings, individualized virtual reality (VR) and group-based rehabilitation were compared with results again emphasising the need to select treatment depending on the specific objective of rehabilitation.(page 738).

An experimental study among elderly people compared enjoyment and task difficulty between real horse riding and a horse riding simulator and suggested that it may be a feasible substitute with comparable benefits to real horseback riding (page 723). Chronic pain impairs physical, mental and social well-being and distraction-based interventions may help divert attention and modulate pain severity. In the systematic review on distraction-based interventions for patients with chronic pain 12 studies were included (page 715). There was a large variation in the implementation of interventions, particularly in the use of practice sessions, dose frequency and duration. Standardized pain, symptom, and outcome measures and tailored intervention approaches focussing on the individual's threshold of distractibility would be helpful to develop greater precision in delivering effective interventions to reduce pain.

Many cultures value the therapeutic use of animals as part of care and enhancing wellbeing. Animal assisted therapy featured in EUJIM very early in the journals life and has consistently attracted high downloads. A systematic review of 36 trials focusses on programmes using different kinds of animals for hospitalised patients of different ages and with different health issue (page 695). Simple hygiene protocols, implementing safety procedures and security precautions appeared to be effective and the review demonstrated that the benefits of introducing an animal programme substantially outweighed any risks. Positive outcomes included reduction in stress, anxiety and pain, changes in vital signs and improvements in nutritional intake. This systematic review has been chosen as the Editor's choice and will be freely accessible for a twelve month period.

Being able to relax ameliorates stress related health problems. A study on students with self-reported stress related physical /or mental symptoms reports on the use of lavender water floral eye masks (page 781). As a method it appeared to reduce autonomic activity in young students with self-reported stress related physical /or mental health problems. The effect of mechanical massage and mental training provided in the workplace demonstrated that there were positive effects, more than for massage alone (page 762). A mind body programme (Relaxation Response Resiliency Program) focussing on physician and self-referred patients with self-reported stress related symptoms and suggests it may be equally effective programme for those experiencing both physical and mental symptoms (page 756). Similarly, receiving mechanical massage and listening to mental training programs, either separately or in combination, during working hours had some positive effects on the employees' heart rate, blood pressure and fingertip temperature (page 762). A feasibility study on the use of Tibetan Singing Bowls suggested they could induce state of wellbeing in patients with cancer and suggested that this was acceptable to patients achieving good attendance and compliance (page 747). A visual tool for subjective distress was more appropriate than validated questionnaires and useful tools for objective data collection were skin conductance level, heart rate variability, and antero-frontal EEG. Authors concluded that the use of Tibetan Bowls appeared to decrease anxiety, arousal, involuntary mental activity and reduce stress.

Problems sleeping are a universal problem but may be seldom reported by patients, particularly those with pain and other co morbidities. This Special section has three studies which explore the management of sleep disorders (pages 769, 789, 797).

A preliminary randomized controlled clinical trial in patients with schizophrenia or depression. Acupuncture slightly improved sleep and depressive symptoms in patients with depression, but did not affect sleep nor influence positive and negative symptoms in patients with schizophrenia (page 789). The response to acupuncture used for patients experiencing insomnia appeared to be unrelated to TCM diagnosis (page 797).

A randomized controlled trial to evaluate US Army active-duty military personnel suffering from insomnia compared the cumulative impacts of a sleep-focused Mind Body Bridging intervention with Zolpidem (usual treatment) for improving sleep (page 769). At 2 month follow up, Mind-Body Bridging appeared to have a clinically meaningful effect in the management of insomnia and may a useful alternative for this population. Auricular acupuncture is often used for stress reduction and insomnia and an article in this issue compares the standards for acupuncture points between European and Chinese systems (page 817). There is also a paper describing a protocol for a systematic review and meta-analysis of randomized controlled trials on acupuncture for the treatment of overactive bladder which is part of the section containing other general articles (page 875).

The final general section of this issue consists of 2 systematic reviews, 7 research articles and 1 protocol (mentioned above). The potential health risks and biological effects of exposure to extremely low frequency magnetic fields (ELF-MF) and electromagnetic radiation (EMR), such as those associated with computers, cell phones, and environmental radiation has been of concern for some years. The fact that these may generate free radicals in biological organisms, led to some preliminary research on the potential efficacy of protective devices constructed with non-metallic and metallic nanoparticles, which may provide a potential means of counteracting deleterious effects by neutralizing harmful radiation before it reaches the body (page 835).

The unique healthcare system in Korea consisting of two independent systems: Western medicine and traditional Korean medicine (TKM) which began in 1998 is described in a paper by Lee et al. (page 841). A review of infertility programmes implementing traditional Korean medicine suggests that it could be an effective and safe option for infertile women (page -847). The clinical practice guidelines developed for atopic dermatitis using evidence-based medicine is expected to lay the groundwork for a high-quality, follow-up clinical study on traditional Korean medicine leading to their standardization and further research (page 854).

The similarities and differences in auricular acupuncture points in terms of their names, locations and therapeutic effects are reviewed and compared between different countries and provide a useful reference for those interested in developing standards in auriculotherapy (page 817). A systematic review assesses different forms of acupuncture for the treatment of chemotherapy-induced leukopenia and provides limited evidence for its use chemotherapy-induced leukopenia, but as with most systematic reviews, the number of studies was limited

and methodological flaws identified (page 802). Despite a high risk of bias systematic review there was promising evidence from a systematic review of 19 studies (N=1483) on the use of acupuncture for Tourette syndrome with significant benefit being observed (page 809).

A randomised controlled trial on 24 honey bee colonies using the homeopathic preparation of Phosphorus 30CH to control against Varroa destructor mites revealed no differences before and after in hive strength or numbers of surviving mites (page 861). The authors suggest that further research is required testing different treatment durations, potencies and administration methods. An experimental study testing highly diluted biotherapeutic of *T. gondii* on mice demonstrated parasite load reduction, neuronal protection and immune system modulation (page 865).

Shortly EuJIM will be moving to article based publishing. This will be a great advantage to all authors as it will speed up production time even further but there will be no running order. In addition EuJIM will have 8 issues per year.

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