

# WORLD'S POULTRY SCIENCE JOURNAL

education  
organization  
research



[www.wpsa.com](http://www.wpsa.com)

volume 75, March 2019 number 1



## GET MORE VALUE FROM YOUR FEED

- Enzymes
- Toxin binders
- Slow release acidifiers
- Immunomodulators
- Flavors
- Raw materials
- Yeast derivatives

**Quality feed additives for  
more cost savings and  
better performance**

---

WORLD'S  
**POULTRY SCIENCE**  
JOURNAL

---

---

Volume 75 March 2019 Number 1

---

1	<b>Editorial</b>
2	<b>Sponsorship</b>
	<b>Reviews</b>
5	Wood-based litter in poultry production: a review <i>M.T. Munir, C. Belloncle, M. Irle and M. Federighi</i>
17	The implication of lighting programmes in intensive broiler production system <i>M.A. Arowolo, J.H. He, S.P. He and T.O. Adebowale</i>
29	Present and potential impacts of waste from poultry production on the environment <i>A.R. Seidavi, H. Zaker-Esteghamati and C.G. Scanes</i>
43	The role of <i>Astragalus membranaceus</i> as immunomodulator in poultry <i>M.R. Farag and M. Alagawany</i>
55	Chicken processing: impact, co-products and potential <i>A.R. Seidavi, H. Zaker-Esteghamati and C.G. Scanes</i>
69	Phenotypic characteristic of junglefowl and chicken <i>T.T. Desta</i>
83	Health promoting and pharmaceutical potential of ferulic acid for the poultry industry <i>M. Saeed, M. Alagawany, S.A. Fazlani, S.A. Kalhoro, M. Naveed, N. Ali, Kifayat-Ullah, M. A. Arain and S. Chao</i>
93	Outlook on EU and Croatian poultry meat market - Partial equilibrium model approach <i>D. Kranjac, K. Zmaić, A. Crnčan and M. Zrakić</i>
105	Behaviour and meat quality of chicken under different housing systems <i>A. El-Deek and K. El-Sabrouh</i>
115	Flavonoids supplementation - An ideal approach to improve quality of poultry products <i>A.A. Kamboh, R.A. Leghari, M.A. Khan, U. Kaka, M. Naseer, A.Q. Sazili and K.K. Malhi</i>
	<b>Summaries</b>
127	Chinese, French, German, Russian, Spanish
	<b>World's Poultry Science Association</b>
151	Information and Officers
155	<b>Obituaries</b>
157	<b>Association News</b>
169	<b>Calendar</b>
171	<b>Education and Training</b>
175	<b>Notes for Contributors</b>

**Editor**

Dr L.A. Waldron  
LWT Animal Nutrition Ltd  
PO Box 119, Feilding 4740  
New Zealand  
Phone: +64 6328 9026,  
Mobile +64 21743374  
Fax: +64 6328 9027  
E-mail: lucy@animalnutrition.co.nz

**Assistant Editor**

Mrs D.M. Kleverwal  
World's Poultry Science Association  
PO Box 31, 7360 AA Beekbergen  
The Netherlands  
Phone: +31 570 541948  
Fax: +31 207 508941  
E-mail: wpsa@xs4all.nl

**Associate Editors**

Prof J.A. Castelló, Spain  
Dr S. Cherepanov, Russia  
Prof D.K. Flock, Germany  
Dr M. Tixier-Boichard, France  
Dr J. Zheng, China

**International Editorial Board**

Prof W. Bessei, Germany  
Prof R.M. Gous, South Africa  
Dr. E.F. Guèye, Mali  
Prof P. Horn, Hungary  
Dr P. Hunton, Canada  
Dr M. Lilburn, USA

Dr R.W.A.W. Mulder, Netherlands  
Dr D. Narahari, India  
Prof. Y. Nys, France  
Prof Jun-ichi Okumura, Japan  
Prof H. Pingel, Germany  
Dr R.A.E. Pym, Australia

Prof J.R. Roberts, Australia  
Prof P.J. Sharp, UK  
Prof P.B. Siegel, USA  
Dr M. Tixier-Boichard, France  
Prof S. Yahav, Israel

---

The **World's Poultry Science Journal** is published in March, June, September and December by the World's Poultry Science Association. The Secretary of the Association is Dr Roel W.A.W. Mulder, PO Box 31, 7360 AA Beekbergen, The Netherlands (phone: +31 6 51519584, fax: +31 207 508 941, e-mail: roel.mulder@wpsa.com, website: www.wpsa.com).

**Disclaimer:** The Editors of the World's Poultry Science Journal take all reasonable steps to ensure the accuracy of material published. However, all statements, conclusions and opinions expressed in it are those of the authors and contributors; the Editors, Associate Editors, Members of the Editorial Board and the Publishers accept no responsibility or liability for them.

**2019 subscriptions rates:** £268/\$483 for organisational online & print; £200/\$369 for organisational online only.

**Subscription enquiries and orders:** Orders, which must be accompanied by payment, may be sent to a bookseller, subscription agent or to the Publisher: Cambridge University Press, Journals Fulfilment Department, University Printing House, Shaftesbury Road, Cambridge, CB2 8BS, UK; or in the USA, Canada and Mexico: Cambridge University Press, Journals Fulfilment Department, 1 Liberty Plaza, Floor 20, New York, NY 10006, USA. EU subscribers (outside the UK) who are not registered for VAT should add VAT at their country rate. VAT registered subscribers should provide their VAT registration number. Japanese prices for institutions are available from: Kinokuniya Company Ltd, PO Box 55, Chitose, Tokyo 156, Japan.

Periodicals postage pending at New York, NY, and at additional mailing offices. Postmaster: send address changes in USA, Canada and Mexico to: World's Poultry Science Journal, Cambridge University Press, Journals Fulfilment Department, 1 Liberty Plaza, Floor 20, New York, NY 10006, USA. Claims for missing issues should be made immediately on receipt of the subsequent issue.

**Back issues:** Dr Roel Mulder, PO Box 31, 7360 AA Beekbergen, The Netherlands.

**Advertising enquiries:** Dr Roel Mulder, PO Box 31, 7360 AA Beekbergen, The Netherlands (phone: +31 6 51519584, fax: +31 207 508 941, e-mail: roel.mulder@wpsa.com).

**Copyright:** All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, optical, mechanical, photocopying, recording or otherwise without the written permission of the copyright holder. © World's Poultry Science Association.

**Reprints and Photocopying:** Readers who require multiple copies of papers published in this journal may either purchase reprints (minimum order 100) or obtain permission to copy from the Editor. However, permission is granted for the making of single copies of articles for internal or personal use. In North America, this permission is granted by the copyright owner for libraries and others registered with the Copyright Clearance Center Inc. (CCC) to make single copies of any article herein for the flat fee of \$3 per article. Payment should be sent directly to CCC, 2 Congress Street, Salem, MA 01970, USA. The item-free Code for this publication indicates that authorization is to make single copies only for internal or personal use. Serial-free Code: ISSN 0043-9339, \$3. In the UK, the Copyright Licensing Agency (CLA), 90 Tottenham Court Road, London W1P 9HE is mandated to grant permission to make single copies.