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SUPPLEMENTARY MATERIAL

A global assessment of aflatoxin M₁ in raw milk and some milk products' research from 2010 to 2024: a bibliometric analysis

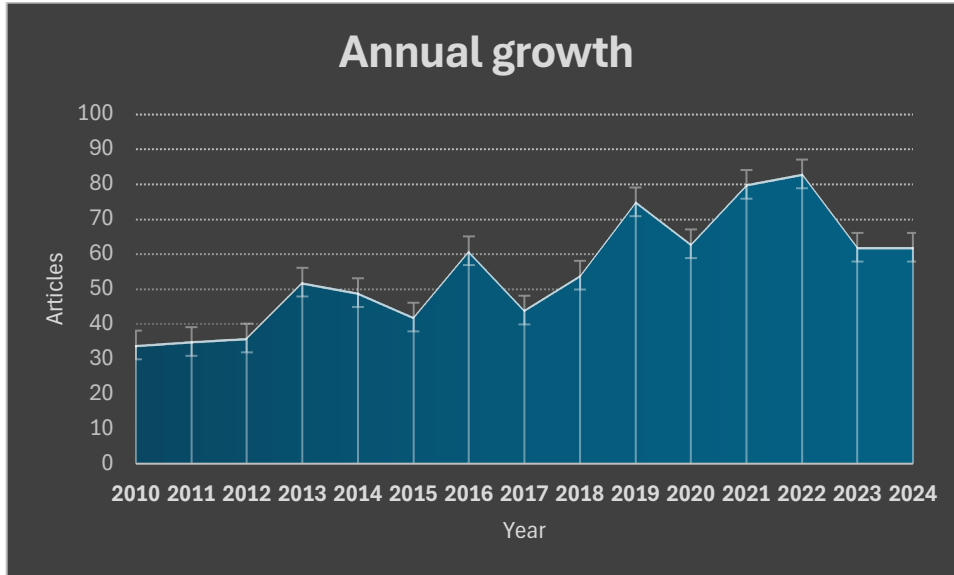
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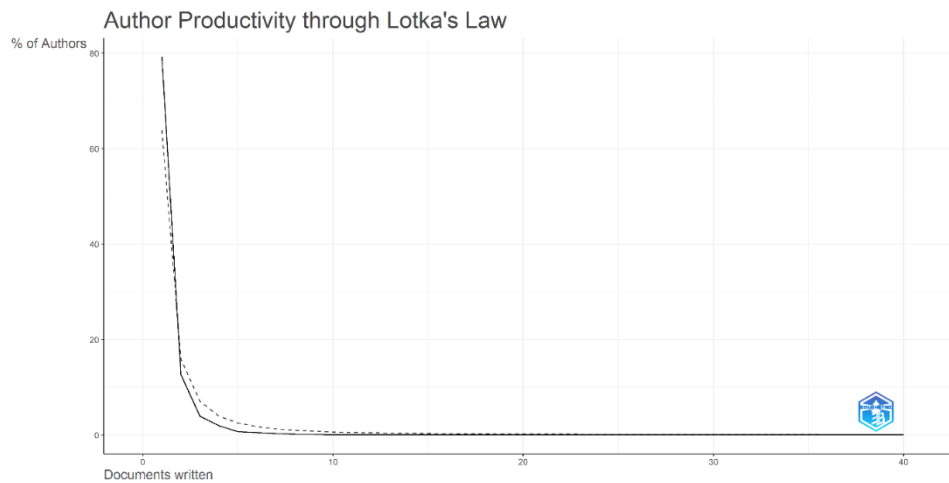
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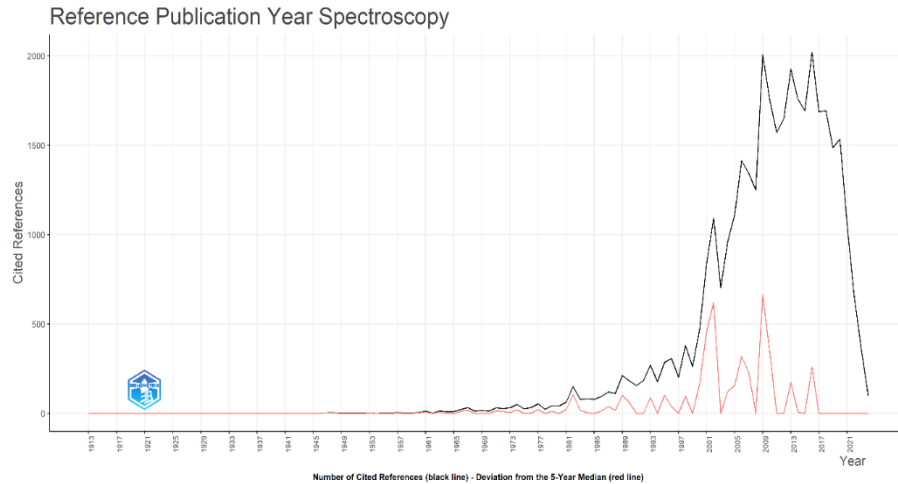
Key words: aflatoxin M₁, bibliometric analysis, raw milk, cheese.



Supplementary Figure 1. Annual growth of publications on aflatoxin M₁ in milk and milk products from 2010 to 2024 (top 25).



Supplementary Figure 2. Lotka's law graph showing the skewed distribution of authors' publications on aflatoxin M₁ in milk and milk products from 2010 to 2024.



Supplementary Figure 3. The spectrogram derived from the bibliometric analysis of aflatoxin M₁ in milk and milk products articles published between 2010 and 2024.

Supplementary Table 1. The 25 most relevant institutions that supported research in aflatoxin M₁ in milk and milk products (2010-2024).

| Affiliation | Country | Type | Articles |
|--------------------------------------------------------|----------|---------------------|----------|
| Ministry of Agriculture and Rural Affairs | China | Research institute | 119 |
| Chinese Academy of Agricultural Sciences | China | Research institute | 110 |
| Institute of Animal Science, CAAS | China | Research institute | 96 |
| Egyptian Knowledge Bank (EKB) | Egypt | Financial Institute | 64 |
| Islamic Azad University | Iran | University | 54 |
| Mashhad University of Medical Sciences | Iran | University | 36 |
| Universidade de Sao Paulo | Brazil | University | 32 |
| Tabriz University of Medical Science | Iran | University | 26 |
| University of Novi Sad | Serbia | University | 23 |
| University of Veterinary and Animal Science - Pakistan | Pakistan | University | 23 |
| Universiti Putra Malaysia | Malaysia | University | 19 |
| Croatian Veterinary Institute Zagreb | Croatia | Research institute | 18 |
| Indian Council of Agricultural Research (ICAR) | India | Research institute | 18 |
| Jiangnan University | China | University | 18 |
| Lebanese University | Lebanon | University | 18 |
| Shahid Beheshti University Medical Sciences | Iran | University | 18 |
| Kermanshah University of Medical Sciences | Iran | University | 17 |
| University of Tehran | Iran | University | 17 |
| ICAR - National Dairy Research Institute | India | Research institute | 16 |
| Ghent University | Belgium | University | 15 |
| University of Zagreb | Croatia | University | 15 |
| CGIAR | France | Research institute | 14 |
| China Agricultural University | China | University | 14 |
| Government College University Faisalabad | Pakistan | University | 14 |
| Nanchang University | China | University | 14 |

Supplementary Table 2. Most cited countries in articles relating to aflatoxin M₁ in milk and milk products (2010-2024).

| Country | TC | Average article citations |
|-----------|------|---------------------------|
| China | 4136 | 27.40 |
| Iran | 3040 | 26.70 |
| Brazil | 1397 | 27.90 |
| Italy | 1234 | 23.30 |
| Turkey | 1117 | 18.90 |
| Usa | 773 | 33.60 |
| Pakistan | 744 | 22.50 |
| India | 724 | 19.60 |
| Serbia | 675 | 28.10 |
| Spain | 569 | 27.10 |
| Lebanon | 497 | 38.20 |
| France | 464 | 58.00 |
| Croatia | 335 | 22.30 |
| Egypt | 325 | 19.10 |
| Greece | 318 | 22.70 |
| Malaysia | 252 | 21.00 |
| Argentina | 214 | 26.80 |
| Portugal | 200 | 25.00 |
| Belgium | 199 | 19.90 |
| Germany | 186 | 20.70 |
| Ethiopia | 174 | 24.90 |
| Nigeria | 160 | 40.00 |
| Korea | 148 | 24.70 |
| Thailand | 141 | 17.60 |
| Vietnam | 141 | 70.50 |

TC, total citations.

Supplementary Table 3. Corresponding authors' countries in the field of study (2010-2024).

| Country | Articles | Articles % | SCP | MCP | MCP % |
|-------------|----------|------------|-----|-----|-------|
| China | 151 | 17.9 | 135 | 16 | 10.6 |
| Iran | 114 | 13.5 | 94 | 20 | 17.5 |
| Turkey | 59 | 7 | 56 | 3 | 5.1 |
| Italy | 53 | 6.3 | 46 | 7 | 13.2 |
| Brazil | 50 | 5.9 | 34 | 16 | 32 |
| India | 37 | 4.4 | 34 | 3 | 8.1 |
| Pakistan | 33 | 3.9 | 20 | 13 | 39.4 |
| Serbia | 24 | 2.8 | 18 | 6 | 25 |
| USA | 23 | 2.7 | 11 | 12 | 52.2 |
| Spain | 21 | 2.5 | 16 | 5 | 23.8 |
| Egypt | 17 | 2 | 11 | 6 | 35.3 |
| Croatia | 15 | 1.8 | 15 | 0 | 0 |
| Greece | 14 | 1.7 | 12 | 2 | 14.3 |
| Lebanon | 13 | 1.5 | 10 | 3 | 23.1 |
| Malaysia | 12 | 1.4 | 8 | 4 | 33.3 |
| Belgium | 10 | 1.2 | 0 | 10 | 100 |
| Mexico | 10 | 1.2 | 8 | 2 | 20 |
| Germany | 9 | 1.1 | 6 | 3 | 33.3 |
| Argentina | 8 | 0.9 | 7 | 1 | 12.5 |
| France | 8 | 0.9 | 1 | 7 | 87.5 |
| Hungary | 8 | 0.9 | 4 | 4 | 50 |
| Portugal | 8 | 0.9 | 8 | 0 | 0 |
| Thailand | 8 | 0.9 | 5 | 3 | 37.5 |
| Ethiopia | 7 | 0.8 | 6 | 1 | 14.3 |
| New Zealand | 7 | 0.8 | 4 | 3 | 42.9 |

SCP, single country publications; MCP, multiple country publications.

Supplementary Table 4. The 25 top-most cited documents on aflatoxin M₁ in milk and milk products (2010-2024).

| Document | DOI | Year | Local citations | Global citations | LC/GC ratio (%) |
|----------------------------------------|--------------------------------|------|-----------------|------------------|-----------------|
| Fallah AA, 2010, Food Chem Toxicol | 10.1016/j.fct.2010.01.014 | 2010 | 72 | 118 | 61.02 |
| Kos J, 2014, Food Control | 10.1016/j.foodcont.2013.09.060 | 2014 | 64 | 135 | 47.41 |
| Skrbic B, 2014, Food Control | 10.1016/j.foodcont.2013.11.039 | 2014 | 58 | 97 | 59.79 |
| Fallah AA, 2011, Food Control | 10.1016/j.foodcont.2011.03.024 | 2011 | 56 | 122 | 45.90 |
| Fallah AA, 2010, Food Control | 10.1016/j.foodcont.2010.04.017 | 2010 | 54 | 107 | 50.47 |
| Asi MR, 2012, Food Control | 10.1016/j.foodcont.2011.10.012 | 2012 | 54 | 96 | 56.25 |
| Duarte SC, 2013, Food Control | 10.1016/j.foodcont.2012.08.002 | 2013 | 52 | 96 | 54.17 |
| Cano-Sancho G, 2010, Rev Iberoam Micol | 10.1016/j.riam.2010.05.003 | 2010 | 47 | 98 | 47.96 |
| Iqbal SZ, 2013, Food Control | 10.1016/j.foodcont.2012.06.026 | 2013 | 47 | 92 | 51.09 |
| Rahimi E, 2010, Food Chem Toxicol | 10.1016/j.fct.2009.09.028 | 2010 | 44 | 89 | 49.44 |
| Picinin LCA, 2013, Food Control | 10.1016/j.foodcont.2012.10.024 | 2013 | 44 | 71 | 61.97 |
| Bahrami R, 2016, Food Control | 10.1016/j.foodcont.2015.10.039 | 2016 | 44 | 100 | 44.00 |
| Britzi M, 2013, Toxins | 10.3390/toxins5010173 | 2013 | 43 | 93 | 46.24 |
| Iha MH, 2013, Food Control | 10.1016/j.foodcont.2012.05.058 | 2013 | 42 | 96 | 43.75 |
| Huang LC, 2014, Food Chem | 10.1016/j.foodchem.2013.09.047 | 2014 | 41 | 170 | 24.12 |
| Hussain I, 2010, Food Control | 10.1016/j.foodcont.2008.12.004 | 2010 | 40 | 76 | 52.63 |
| Tomasevic I, 2015, Food Control | 10.1016/j.foodcont.2015.03.017 | 2015 | 40 | 76 | 52.63 |
| Schrenk D, 2020, EFSA J | 10.2903/j.efsa.2020.6040 | 2020 | 40 | 374 | 10.70 |
| Bilandzic N, 2010, Food Control | 10.1016/j.foodcont.2010.03.003 | 2010 | 39 | 65 | 60.00 |
| Gürbay A, 2010, Food Chem Toxicol | 10.1016/j.fct.2009.10.016 | 2010 | 38 | 83 | 45.78 |
| Zheng N, 2013, Food Control | 10.1016/j.foodcont.2012.06.020 | 2013 | 38 | 63 | 60.32 |
| El Khoury A, 2011, Food Control | 10.1016/j.foodcont.2011.04.001 | 2011 | 37 | 117 | 31.62 |
| Siddappa V, 2012, Food Chem Toxicol | 10.1016/j.fct.2012.08.034 | 2012 | 37 | 57 | 64.91 |
| Elsanhoty RM, 2014, Food Control | 10.1016/j.foodcont.2014.03.002 | 2014 | 37 | 122 | 30.33 |
| Nguyen BH, 2013, Mat Sci Eng C-Mater | 10.1016/j.msec.2013.01.044 | 2013 | 36 | 128 | 28.13 |

LC, local citations; GC, general citations.

Supplementary Table 5. Country collaboration, world map.

| From | To | Frequency |
|-----------|----------------|-----------|
| Australia | Chile | 1 |
| Australia | Kuwait | 1 |
| Austria | Australia | 1 |
| Austria | Cameroon | 1 |
| Austria | Colombia | 1 |
| Austria | Czech Republic | 1 |
| Austria | Ireland | 2 |
| Austria | Slovakia | 1 |
| Belgium | Austria | 1 |
| Belgium | Kenya | 2 |
| Belgium | Netherlands | 1 |
| Belgium | Russia | 1 |
| Belgium | South Africa | 1 |
| Belgium | Sweden | 2 |
| Belgium | Tanzania | 1 |
| Brazil | Argentina | 1 |
| Brazil | Austria | 1 |
| Brazil | Belgium | 1 |
| Brazil | Czech Republic | 2 |
| Brazil | Denmark | 1 |
| Brazil | Ireland | 1 |
| Brazil | Japan | 1 |
| Brazil | Korea | 1 |
| Brazil | Pakistan | 4 |
| Brazil | Usa | 8 |

Supplementary Table 6. Authors' collaboration in the field of study under investigation (2010-2024).

| Node | Cluster | Betweenness | Closeness | PageRank |
|--------------|---------|-------------|-----------|----------|
| asi mr | 1 | 0 | 1 | 0.059 |
| iqbal sz | 1 | 0 | 1 | 0.059 |
| zhang w | 2 | 0 | 0.5 | 0.054 |
| li pw | 2 | 0 | 0.5 | 0.061 |
| zhang q | 2 | 0 | 0.5 | 0.061 |
| corassin ch | 3 | 0 | 0.5 | 0.06 |
| oliveira caf | 3 | 0 | 0.5 | 0.056 |
| rosim re | 3 | 0 | 0.5 | 0.06 |
| wang jq | 4 | 0 | 0.25 | 0.083 |
| zheng n | 4 | 0 | 0.25 | 0.083 |
| li sl | 4 | 0 | 0.25 | 0.05 |
| gao yn | 4 | 0 | 0.25 | 0.05 |
| yang x | 4 | 0 | 0.25 | 0.028 |
| bilandzic n | 5 | 0 | 0.333 | 0.06 |
| varenina i | 5 | 0 | 0.333 | 0.06 |
| cvetnic z | 5 | 0 | 0.333 | 0.058 |
| kolanovic bs | 5 | 0 | 0.333 | 0.058 |

Supplementary Table 7. Factorial analysis of keywords of articles on aflatoxin M₁ in milk and milk products from 2010 to 2024 (top 25 keywords).

| Word | Dim1 | Dim2 | Cluster |
|------------------|-------|-------|---------|
| milk | 0.24 | -0.04 | 1 |
| mycotoxins | -0.08 | -0.07 | 1 |
| aflatoxin m1 | -0.07 | 0.98 | 1 |
| m-1 | -0.01 | 0.82 | 1 |
| aflatoxin m-1 | -0.17 | -1.09 | 1 |
| m1 | -0.33 | -1.08 | 1 |
| contamination | -0.73 | -0.18 | 1 |
| products | -0.31 | 0.17 | 1 |
| elisa | -0.82 | 0.34 | 1 |
| b-1 | 0.41 | 0.08 | 1 |
| exposure | -0.22 | -0.12 | 1 |
| dairy-products | -0.83 | -0.03 | 1 |
| raw-milk | -1.17 | -0.30 | 1 |
| samples | -0.88 | -0.15 | 1 |
| feed | -0.18 | -0.70 | 1 |
| food | 0.49 | -0.15 | 1 |
| ochratoxin | 0.40 | -0.08 | 1 |
| uht milk | -1.57 | 0.22 | 1 |
| cheese | -0.85 | -0.34 | 1 |
| hplc | -0.75 | 0.04 | 1 |
| aflatoxin | 0.38 | -0.59 | 1 |
| aflatoxins | 0.52 | -0.14 | 1 |
| food safety | 0.31 | -0.02 | 1 |
| province | -2.09 | -0.17 | 1 |
| pasteurized milk | -1.89 | 0.12 | 1 |

Supplementary Table 8. Factorial analysis of authors of articles on aflatoxin M₁ in milk and milk products from 2010 to 2024 (top 25 keywords).

| Documents | dim1 | dim2 | contrib | TC | Cluster |
|-------------------------------------------|-------|-------|---------|-----|---------|
| schrenk d, 2020, efsa j | 0.18 | 0.18 | 0.00 | 374 | 1 |
| huang lc, 2014, food chem | 0.17 | 0.17 | 0.00 | 170 | 1 |
| andrade pd, 2013, j chromatogr a | 0.16 | 0.16 | 0.00 | 146 | 1 |
| kos j, 2014, food control | 0.13 | 0.13 | 0.00 | 135 | 1 |
| nguyen bh, 2013, mat sci eng c-mater | 0.03 | 0.03 | 0.00 | 128 | 1 |
| khoshfetrat sm, 2018, biosens bioelectron | 0.12 | 0.12 | 0.00 | 125 | 1 |
| fallah aa, 2011, food control | -0.51 | -0.51 | 0.00 | 122 | 1 |
| elsanhoty rm, 2014, food control | 0.34 | 0.34 | 0.00 | 122 | 1 |
| fallah aa, 2010, food chem toxicol | -0.56 | -0.56 | 0.00 | 118 | 1 |
| el khoury a, 2011, food control | 0.26 | 0.26 | 0.00 | 117 | 1 |
| corassin ch, 2013, food control | 0.00 | 0.00 | 0.00 | 113 | 1 |
| juan c, 2014, food control | 0.17 | 0.17 | 0.00 | 112 | 1 |
| fallah aa, 2010, food control | -0.63 | -0.63 | 0.00 | 107 | 1 |
| istamboulié g, 2016, talanta | 0.13 | 0.13 | 0.00 | 107 | 1 |
| dinçkaya e, 2011, biosens bioelectron | -0.15 | -0.15 | 0.00 | 104 | 1 |
| bahrami r, 2016, food control | -0.62 | -0.62 | 0.00 | 100 | 1 |
| paniel n, 2010, sensors-basel | 0.15 | 0.15 | 0.00 | 98 | 1 |
| cano-sancho g, 2010, rev iberoam micol | 0.00 | 0.00 | 0.00 | 98 | 1 |
| skrbic b, 2014, food control | -0.05 | -0.05 | 0.00 | 97 | 1 |
| asi mr, 2012, food control | -0.28 | -0.28 | 0.00 | 96 | 1 |
| duarte sc, 2013, food control | -0.18 | -0.18 | 0.00 | 96 | 1 |
| iha mh, 2013, food control | 0.04 | 0.04 | 0.00 | 96 | 1 |
| zhang j, 2015, food chem toxicol | 0.27 | 0.27 | 0.00 | 93 | 1 |
| britzi m, 2013, toxins | 0.25 | 0.25 | 0.00 | 93 | 1 |
| iqbal sz, 2013, food control | -0.30 | -0.30 | 0.00 | 92 | 1 |

Supplementary Table 9. Top 25 keywords relating to aflatoxin M₁ in milk and milk products from 2010 to 2024.

| Words | Occurrences |
|------------------|--------------------|
| milk | 363 |
| mycotoxins | 321 |
| aflatoxin m1 | 308 |
| m-1 | 270 |
| aflatoxin m-1 | 220 |
| m1 | 203 |
| contamination | 178 |
| products | 163 |
| elisa | 143 |
| b-1 | 134 |
| exposure | 127 |
| dairy-products | 124 |
| raw-milk | 109 |
| samples | 100 |
| feed | 92 |
| food | 90 |
| ochratoxin | 87 |
| uht milk | 71 |
| cheese | 70 |
| hplc | 62 |
| aflatoxin | 61 |
| aflatoxins | 56 |
| food safety | 49 |
| province | 49 |
| pasteurized milk | 48 |