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Original Article

Web-Based Ration Balancing Tool

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ABSTRACT

Nowadays, there is an increasing demand for free software for broiler ration balancing, which is evident within relevant scientific and professional communities. While some available applications account for certain procurement costs, more affordable options usually come with limited functionality. Many users require customized solutions that meet their specific needs. Developing such projects requires collaboration between professionals in animal feed technology, animal science, and software development. Multidisciplinary projects could develop much faster if teams were not required to build solutions from scratch. The availability of open-source code, ready for modification and further development, could significantly enhance efficiency in these endeavors. The Web-Based Ration Balancing Tool (WBRB) is a server-side application designed to optimize the formulation of rations for chicken broilers. This tool streamlines the process of creating ration recipes, reducing the risk of errors associated with manual calculations or general spreadsheet-based solutions. With proper software integration, WBRB can even run offline. This free and open-source application is available to all interested users, and developers can modify the existing code to meet specific needs and requirements. WBRB is built using HTML and PHP, with MySQL as its relational database management system.

INTRODUCTION

Feed mixing in broiler nutrition is a fundamental aspect of feed technology and plays a crucial role in meeting animal nutritional needs. Given the wide range of requirements involved, this process is far from simple. Manual calculations are time-consuming and prone to errors. While various spreadsheet-based software solutions can assist with tabular calculations, mistakes can still occur. Large companies and entrepreneurs often hire professional developers to create custom software or purchase existing solutions. However, market options come with certain limitations. At first glance, some applications appear to have an excellent graphical user interface (GUI). However, users soon realize that their options are limited unless they upgrade to a premium version. Njorge (2025) has developed a particularly efficient GUI, but a full functionality upgrade is required. High-quality, professional desktop solutions are available, but they require users to purchase a license. It is the case with WinFeed, developed by EFG Software (2025). Other suitable software products may also involve purchase fees. One example of such feed formulation software is AFOS (2024). An alternative approach involves free, web-based platforms with well-designed GUIs, though they also have restrictions on editing animal nutritional requirements. For instance, Feed Access (2024) has developed such a feed formulation application for poultry, pigs, and fish. To tackle these challenges, this project aimed to develop an open-source, web-based application focused on continuous improvement. The final product is an application available upon request, open to modifications, and adaptable to the specific needs of users.

MATERIALS AND METHODS

The basic menu and navigation system was developed using HTML, the standard markup language for web pages according to instructions of the HTML Tutorial (2025). The feed databases were designed using values and data from information systems. For that purpose tables of composition and nutritional values of feed materials by INRA CIRAD AFZ (2024) were used, as well as animal feed resources information system developed by Feedipedia (2025). MySQL was chosen as the relational database management system, described by Smirnova & Tezuysal (2022), while PHP, a server-side scripting language, was used to handle database operations according to the description of Nixon (2021). In code development, functionality and simplicity take priority over design. This approach was chosen based on the target group's profile. The project is intended for professionals in broiler nutrition who possess the necessary skills. Additionally, the code is developed as open-source, ensuring a straightforward design so that anyone interested in further development can do so without the need for reverse engineering. For the purpose of application development, nutrient requirements for total rations were according to the specifications of the National Research Council (1994) as well those by Leeson & Summers (2005). For supplemental minerals and vitamins, the requirements by McDonald *et al*. (2010) were considered. However, due to open-source nature of this project, all potential users are able to adjust requirements in WBRB.

RESULTS

On the main page, the initial menu is displayed. This menu includes the items: "Requirements," "Feeds," "Ration," "Recipe," "Diet Examples", and "Terms of Use." Each of these items is a link that navigates to a corresponding page, each serving a specific purpose (Figure 1).

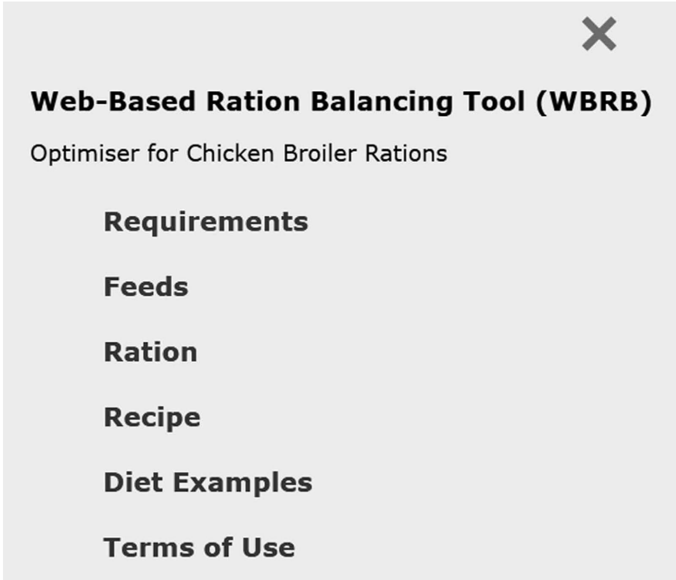

Figure 1 – Main page.

When a page is rendered in a web browser, it is important that the user navigates only using the rendered links, not the browser's navigation bar.

Requirements Page

In the WBRB project database, requirements are stored in the table "reqexpo". The basic element on this page is a select tag (Figure 2), in which one out of three diet plans may be selected, according to Leeson & Summers (2005).

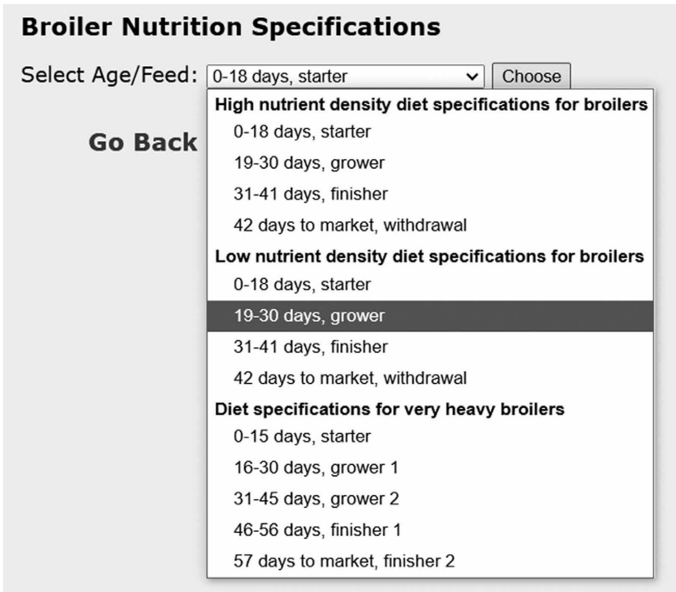

Figure 2 – Requirements page.

Requirements could be adjusted or even completely changed according to user's preferences, due to the open-source nature of the code. However, user modifications that include adding new columns to a database table for additional nutritional parameters require corresponding adjustments to dependent database tables and PHP scripts. During the operational use of WBRB, when requirements are selected and the "Choose" button is clicked, they are copied from the "reqexpo" table to the "reqslctd" table until the next requirement selection. Requirements selected from this table will be used later, in ratio balancing. When requirements are selected, the user has to get back to the main page by clicking on "Go Back" link. For the requirements examples, data from various sources was used (National Research Council, 1994; Leeson & Summers, 2005; McDonald *et al*., 2010). According to Leeson & Summers (2005), requirements for the majority of parameters - such as metabolizable energy (ME), crude protein (CP), amino acids (AA), and almost all liposoluble vitamins (A, D3, and E) - are considered for the total ration. The same applies to vitamin K, except that National Research Council (1994) data sources are used. However, most international companies now publish requirements for supplementary vitamins and trace mineral levels for their branded broilers. Therefore, the same approach is applied to this model, according to requirements by McDonald *et al*. (2010).

Feeds page

On the "Feeds" page, the links "Master Feed Library", "User Feed Library", "Delete User Feeds", and "Go Back" are present. While the last of those is a navigational link that leads back to main page, all the others are important for feed operations (Figure 3).

In WBRB projects, feeds are stored in two database tables. The "masterfeeds" table is non-editable and serves the purpose of feed selection and transfer to the "userfeeds" table, where the chemical composition of feeds can be edited. The data sources for "masterfeeds" are highly reliable. They are based on tables of composition and nutritional values of feed materials by INRA CIRAD AFZ (2024) and on the animal feed resources information system by Feedpedia (2025). However, some caution is still necessary. It is well known that feed composition can vary significantly due to various factors such as harvest conditions, storage, processing, among others. Therefore, users should always edit feed composition in the "userfeeds" table, especially if chemical analysis data is available. In such cases, it is crucial to update crude protein, starch, fat, and sugar content, as these are used to calculate metabolizable energy content according to equation described in Regulation No 152/2009 by the European Commission (2009).

Master Feed Library Page

This page serves as an interface for selecting feeds that the user wants to transfer from the "masterfeeds" database table to the "userfeeds" table. Feeds are classified into nine groups: cereal grains, cereal byproducts, legumes and oilseeds, oil byproducts, other plant products, animal products, oils and fats, mineral products, and supplements. Each group is placed in a separate box. To the left of each feed, there is a checkbox that the user must select for the feeds to be transferred to the "userfeeds" table. The transfer occurs upon clicking the "Transfer selected feeds to user feed library" button (Figure 4).

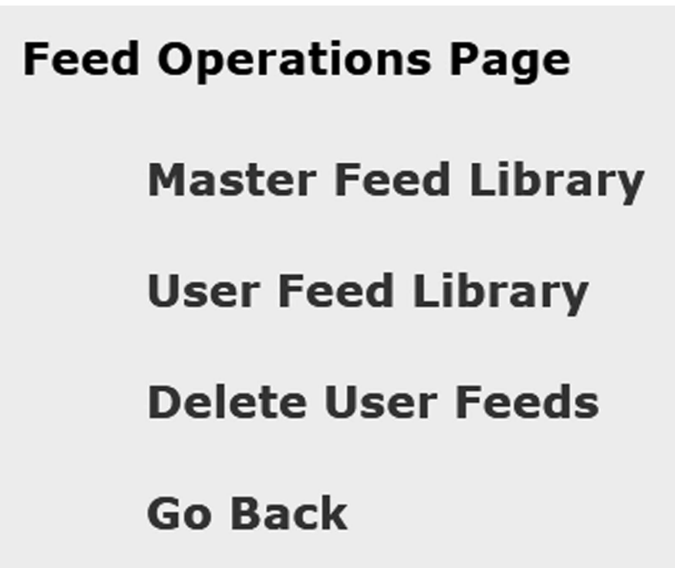

Figure 3 – Feeds page.

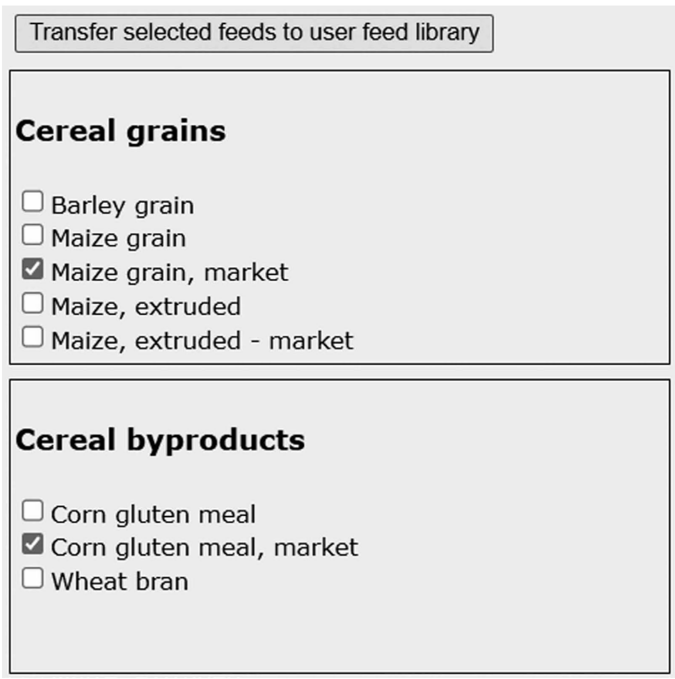

Figure 4 – Master feed library page.

Before transferring feeds from the "Master Feed Library," it is highly recommended to verify whether they have already been added to the "User Feed Library." Initially, common broiler feeds are already included in the "User Feed Library."

User Feed Library Page

This page displays a table of feeds stored in the "userfeeds" database table. The first column contains the feed ID from the database, while the other columns represent the feed group, feed name, and basic nutritional parameters. In addition to basic parameters (ME, CP), the table includes data on the most important amino acids. These include lysine, methionine & cystine, methionine, threonine, and tryptophan. To the right of the ID column, under the magnifying glass icon, is a column in which in every row contains a button with the "double greater than" symbol (Figure 5).

ID	🔍	Group	Feed
417	>>	Cereal grains	Maize grain, market
464	>>	Cereal grains	Maize, extruded - market
430	>>	Oil byproducts	Soybean meal, 46% CP - market
431	>>	Oil byproducts	Sunflower Meal, 33%CP - market
422	>>	Mineral products	Calcium carbonate
423	>>	Mineral products	Monocalcium phosphate
420	>>	Mineral products	Sodium chloride
436	>>	Supplements	Premix, market

Figure 5 – User feed library page.

Clicking on that button leads to a page for detailed feed composition overview and editing (Figure 6).

Non-editable items are displayed in red font when the code is executed. These include the feed ID number, the group in which the feed is classified, and the ME content. Energy content is the result of a calculation based on CP (Figure 6), fat, starch, and sugar content (Figure 7), which should be edited to change ME content. These are typically the results of feed chemical analyses. However, proper data is not always available. In such cases, users may need to rely on whatever information is accessible, such as recent analyses from suppliers combined with their professional expertise in poultry nutrition. When data is completely lacking, less experienced nutritionists are advised to use the original feed composition values already provided in the code-related databases.

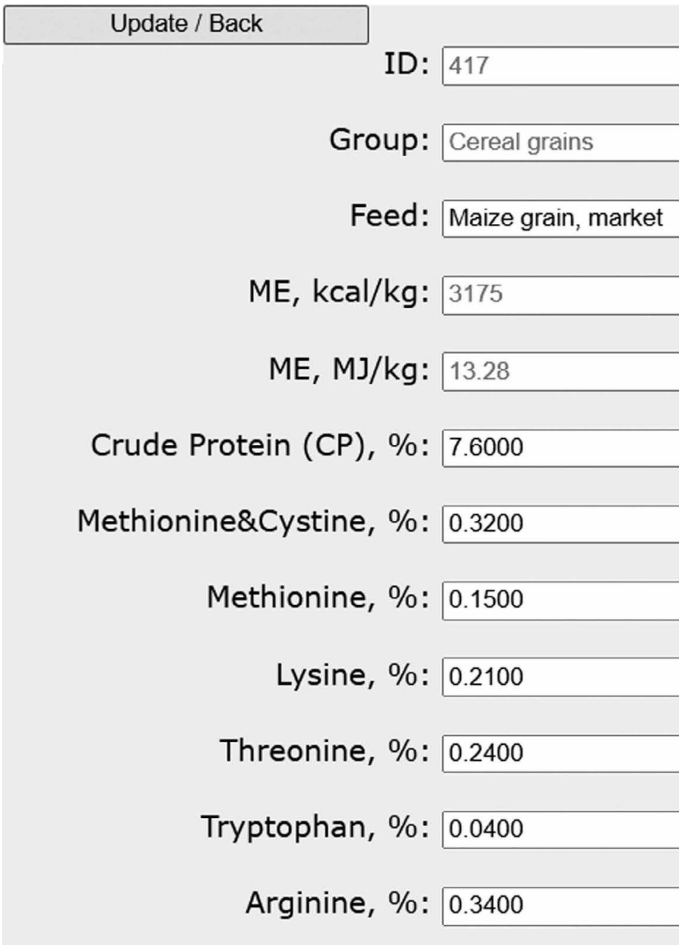

Figure 6 – Feed viewer and editor.

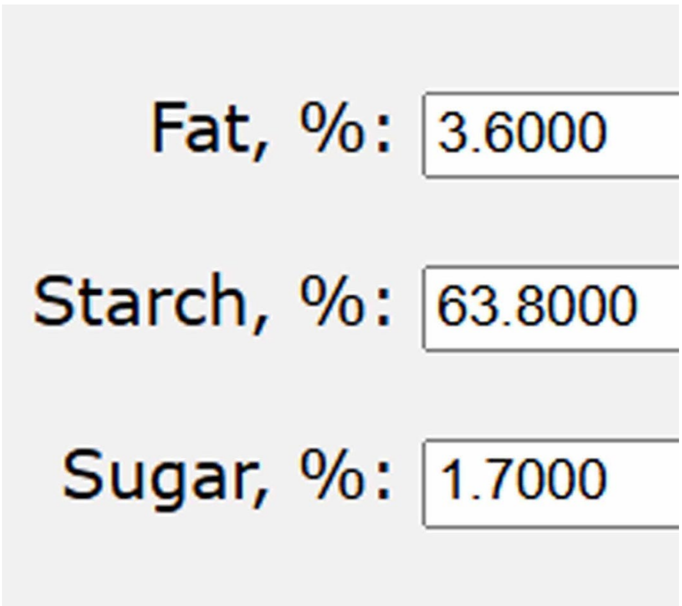

Figure 7 – Feed viewer and editor.

At the bottom of this page, in the left corner, there is a check-box with a "copy" button next to it (Figure 8).

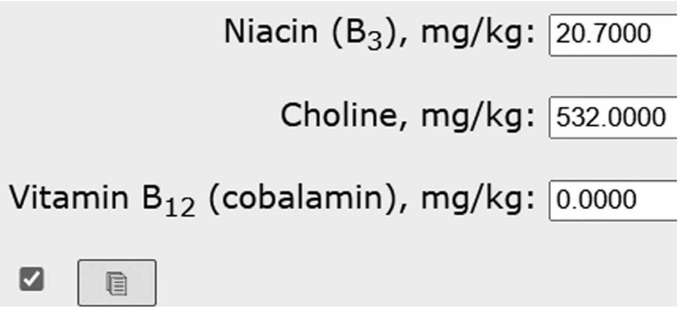

Figure 8 – Feed duplication check-box and copy button.

By checking the checkbox and clicking the copy button, the feed will be duplicated in the "userfeeds" table and subsequently rendered on the "User Feed Library" page. This is useful for adding new feeds by duplicating similar ones. After that operation, less time will be required for editing duplicated feed, since the user starts with the feed name and other required parameters in every situation.

Delete User Feeds Page

This is a simple interface for deleting feeds from the "userfeeds" database table. Deleted feeds will no longer be rendered on the "User Feed Library" page. The deletion process requires the user to check the feeds to be deleted and click the 'Delete' button (Figure 9).

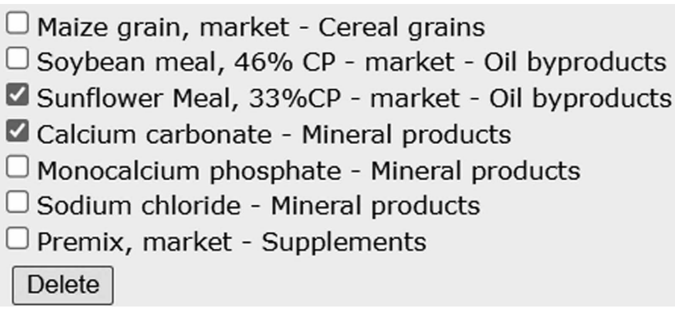

Figure 9 – Delete user feeds page.

Ration page

Upon clicking this link on the main page, users can choose to either create a new ration or edit the current one. If they opt to edit the current ration, they are redirected to the ration balancing page. However, if they choose to create a new ration, an interface for selecting the feeds to be included in the ration appears before the redirection (Figure 10).

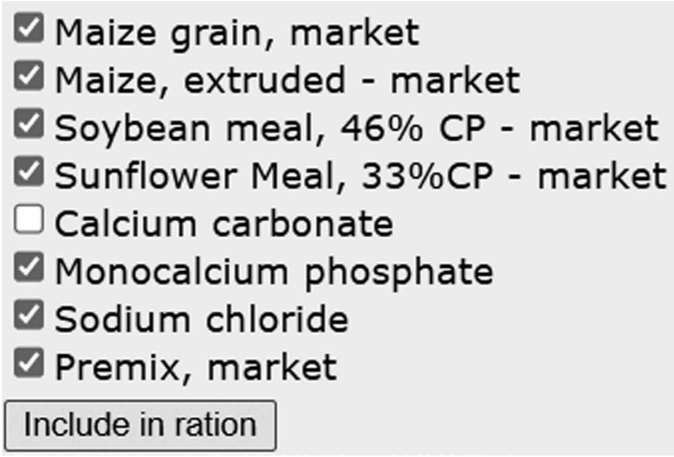

Figure 10 – Feed selection for ration.

Upon a click on a button "Include in ration" (Figure 10), the page for ration balancing is generated, with a left and right panel. On the left panel there are input tags for the amount of feeds in percentages (Figure 11).

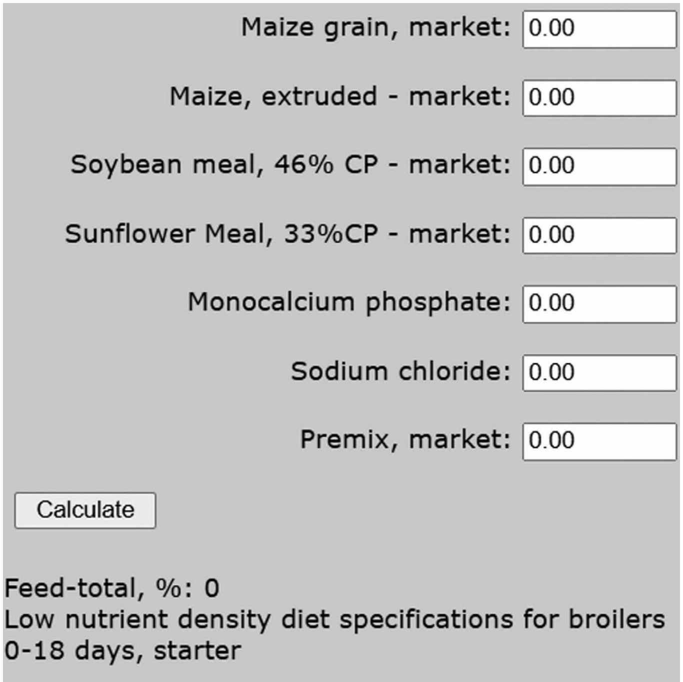

Figure 11 – Left panel in ration balancing page.

At the bottom of the left panel, there are remarks about the selected nutrition plan, broiler age, and the feed type for that age. Next to these remarks is the total of all feed amounts, which must be set to 100 once the amount of each selected feed is adjusted in the best way to meet the selected requirements. In certain cases, when more feeds are included in the ration, a vertical scroll bar will be generated on the right side of the panel, in order to reach the described remarks, and the button "Calculate". After each adjustment on amounts of feeds, the user has to click on that button to trigger the recalculation of rations. The right panel generates three vertical tables, which can be navigated using the vertical scroll bar on the right. The first table (Table 1) is a report on the basic ration's nutritional parameters (ME, CP, AA).

Table 1 – Basic nutritional parameters.

Parameters	In ration	Requirements	Balance
ME, Kcal/kg	2961	2850	1.04
ME, MJ/kg	12.39	11.93	1.04
Crude protein, %	21.77	21	1.04
Methionine, %	0.66	0.45	1.46
Methionine & cystine, %	0.94	0.9	1.05
Lysine, %	1.21	1.2	1.01
Threonine, %	0.77	0.68	1.14
Tryptophan, %	0.23	0.21	1.09
Arginine, %	1.31	1.3	1.01
Valine, %	0.91	0.78	1.17
Leucine, %	1.82	1.2	1.51
Isoleucine, %	0.8	0.68	1.18
Histidine, %	0.5	0.37	1.34
Phenylalanine, %	0.98	0.7	1.4

The second table (Table 2) presents the total mineral and vitamin content in the ration.

Table 2 – Minerals and vitamins in total rations.

Minerals and vitamins	In ration	Requirements	Balance
Total calcium, %	0.96	0.95	1.01
Available Phosphorus, %	0.46	0.45	1.01
Sodium, %	0.22	0.22	1
Manganese, mg/kg	137.26	70	1.96
Iron, mg/kg	231.34	20	11.57
Copper, mg/kg	30.14	8	3.77
Zinc, mg/kg	153.56	70	2.19
Iodine, mg/kg	1.48	0.5	2.96
Selenium, mg/kg	0.46	0.3	1.53
Vitamin A, IU/kg	16365	8000	2.05
Vitamin D_3, IU/kg	5500	3500	2
Vitamin E, IU/kg	111.92	50	2.24
Vitamin K, mg/kg	4.413	0.5	8.83
Thiamin (B_1), mg/kg	8.03	4	2.01
Riboflavin (B_2), mg/kg	11.567	5	2.31
Pyridoxine (B_6), mg/kg	9.773	4	2.44
Pantothenic Acid, mg/kg	26.656	14	1.9
Folic Acid, mg/kg	2.656	1	2.66
Biotin, mg/kg	0.484	0.1	4.84
Niacin, mg/kg	105.561	40	2.64
Choline, mg/kg	2969.82	400	7.42
Vitamin B_{12}, mg/kg	0.037	0.012	3.11

The third table (Table 3) shows supplementary trace minerals and vitamins.

Table 3 – Supplementary trace minerals and vitamins.

Supplementary	In ration	Requirements	Balance
Mn, mg/kg	120	120	1
Fe, mg/kg	40.2	40	1.01
Cu, mg/kg	16.2	16	1.01
Zn, mg/kg	120	100	1.2
I, mg/kg	1.29	1.25	1.03
Se, mg/kg	0.3	0.3	1
Vitamin A, IU/kg	14400	12000	1.2
Vitamin D_3, IU/kg	5400	5000	1.08
Vitamin E, IU/kg	81	75	1.08
Vitamin K, mg/kg	4.2	3	1.4
Thiamin, mg/kg	5.1	3	1.7
Riboflavin, mg/kg	9	8	1.13
Pantothenic acid, mg/kg	18.9	13	1.45
Niacin, mg/kg	72	55	1.31
Choline, mg/kg	1800	1600	1.13
Vitamin B_{12}, mg/kg	0.021	0.016	1.31

The example shown in Tables 1-3 is for a starter feed for the age 0-18 days, in a low nutrient dense diet. The ration composition is presented in Table 4.

Table 4 – Ration example.

Feed	In ration, %
Maize grain, market	46.58
Maize, extruded - market	8.00
Corn gluten meal, market	5.00
Soybean, whole, extruded - market	11.10
Soybean meal, 46% CP - market	12.40
Sunflower Meal, 33%CP - market	3.00
Feather meal, market	1.00
Fish meal, protein 65% - market	5.00
Fish oil, herring - market	1.00
Sunflower oil, market	1.00
Calcium carbonate	0.27
Monocalcium phosphate	1.37
Sodium bicarbonate	0.26
Sodium chloride	0.23
DL-Methionine	0.30
L-Arginine	0.14
L-Lysine	0.20
L-Threonine	0.10
L-Tryptophan	0.05
Premix, market	3.00
Total	**100.00**

Each table in the right panel has four columns. The first column contains the nutritional parameter title, the second shows its content in the ration, the third presents the requirements for the corresponding parameter, and the fourth column displays an index representing the balance efficiency between content and requirements. For example, if the energy content balance is 1.04, it means that the ration contains 4% more energy than the predicted requirement. For key parameters like ME (Metabolizable Energy) and CP (Crude Protein), it is optimal for the balance index to fall between 0.95 and 1.05. A rule of thumb is to achieve the same balance index for the energy and protein. For the AA balance, wider poultry nutrition knowledge is important. Users should be well informed about amino acid metabolic paths, since some of them are precursors for others. For example, in poultry metabolism, methionine serves as an indirect precursor to cystine, according to Pacheco *et al*. (2018). This is particularly important when making decisions about including certain synthetic amino acid forms in the ration. At first glance (Table 2), balance index for mineral and vitamin content may appear to be very high in the total ration, which should be considered with caution. The data on feed composition in the "masterfeeds" database table are generally reliable. Those are based on the table of composition and nutritional values of feed materials by INRA CIRAD AFZ (2024) and the animal feed resources information system by Feedipedia (2025). However, users should always keep in mind that the mineral and vitamin contents, as well as their availability in feeds, may vary per location, as well as due to many other factors (e.g. harvest, storage, transport, and processing). Even with updated data based on chemical analyses in user feed library, data accuracy and the potential availability of vitamin and mineral forms in feeds still has to be carefully considered. For that reason, many international companies present vitamin and mineral requirements for their branded broilers on a supplemental level. This is exactly why in Table 3, in the right panel for ration balancing, the same approach is applied, with proper supplemental requirements according to McDonald *et al*. (2010). Again, those requirements can be edited, considering the code's open-source, with the potential to include recommendations published by international producers of branded broilers, when authorized.

Other pages

The last-created ration is always stored in the "Recipe" page, as long as the new ration isn't balanced. This page includes a "Print Recipe" button that allows users to print the ration report. Some of rations included for practice are in the "Diet Examples" page. In the page "Terms of Use", developers engaged in further code transformation may place any appropriate information that they find useful (e.g. original code builder or conditions for use of further projects). This page originally displays the project's MIT license, along with a link to the GitHub repository where the original code can be downloaded. The code is distributed via the GitHub repository maintained by Radivojević (2025).

DISCUSSION

Although various commercial software products for poultry nutrition come adjusted for various display resolutions, it is not the case with WBRB, for a few reasons. As mentioned, both the application for use and the code for further development designed as open source. In this context, the extensive and diverse public using the tool is bound to have different ideas for code editing, especially for different display resolutions. WBRB was initially designed for the 1920x1080 display resolution. According to statistics by Statcounter Global Stats (2025), this resolution had a highest market share in the period January 2024-January 2025 considering all platforms (8.65%), and especially desktop platforms (23.8%). Not that the solutions initially developed for mobile devices do not exist – one was developed by Njorge (2025) - but the pertinence of such GUI environment is debatable. Ration balancing is an important and sensitive process, and it is often more appropriate to work on larger displays and resolutions to do it. However, further development in responsive design is possible, given the open source code nature of WBRB. Large companies and entrepreneurs frequently hire professional developers to build custom software or purchase existing solutions. Available market options often come with limitations. While some applications initially appear to have excellent GUI, users soon realize that essential features are restricted unless they upgrade to a premium version, like with the one developed by Njorge (2025). High-quality, professional desktop solutions exist, but typically require a paid license, such as WinFeed developed by EFG Software (2025). Other suitable software options may also involve purchase fees, such as the feed formulation software by AFOS (2024). Alternatively, free web-based platforms with well-designed GUIs are available, although they may impose restrictions on modifying animal nutritional requirements. For instance, applications such as the feed formulation tool for poultry, pigs, and fish developed by Feed Access (2024). Although WBRB is free and open source, it may incur some costs for domain registration and hosting. However, those costs are significantly low, and do not exceed 60 US dollars per year. On the other hand, even those costs may be avoided. There is a possibility to run WBRB in offline mode, upon the installation of proper software. A very effective solution for this approach is the free XAMPP software, which is well-documented, features an intuitive GUI, and serves as an ideal platform for offline use of the WBRB. A comprehensive description of XAMPP is presented by Blum (2018).

CONCLUSION

Currently, there is a growing need for free software dedicated to broiler ration balancing. This demand is evident within both scientific and professional communities in the field of animal nutrition. Requests for specialized solutions frequently arise from technologists in animal feed production, farmers, agronomists, and veterinarians. While some applications are available, more affordable options often come with limited functionality. Additionally, many users require customized solutions tailored to their specific needs. Developing such projects often requires collaboration between professionals in animal feed technology, animal science, and software development. While this collaboration is valuable, significant time can be lost as these diverse experts work to align their understanding. Multidisciplinary projects could progress much faster if teams were not required to build solutions from scratch. The availability of open-source code, which is ready for modification and further development, can significantly improve efficiency in such projects. This paper presents a potential open-source solution, designed as a starting point for future development. Unlike a fully developed commercial application, which is often limited in its ability to be modified, this solution provides greater flexibility for customization and expansion.

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AUTHOR CONTRIBUTIONS

Conceptualization, MR and AM; methodology, MR; software, MR; validation, MR, AM and VR; formal analysis, MR; investigation, AM; resources, MR; data curation, MR; writing—original draft preparation, MR; writing—review and editing, AM, VR; visualization, AM, VR; supervision, MR; project administration, MR; funding acquisition, MR, MA and VR. All authors have read and agreed to the published version of the manuscript.

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DATA AVAILABILITY STATEMENT

Given that this paper is the result of an open-source project, it ensures full data accessibility upon publication. Any interested users are free to further develop the code. Both the code and database are available upon request from the corresponding author. However, the research team would appreciate proper citation of this paper in any subsequent developments.

CONFLICT OF INTEREST

The authors declare no conflicts of interest. The funders had no role in the study’s design, data collection, analysis, interpretation, or manuscript preparation.

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