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A Review of the Nutritional use of Cowpea (Vigna Unguiculata L. Walp) for Human and Animal diets

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Abstract

Cowpea (Vigna unguiculataL. Walp) is a popular legume crop tended primarily in Africa and used for mortal and beast diets each over the world. Despite this, little study has been done on it, and it's the least used palpitation crop in comparison to others. thus, the thing of this thorough paper was to give sapience and conflation into the salutary and phenolic status of cowpeas, as well as their impact on mortal and beast diets. In addition, protein, lipids, carbohydrates, vitamins, salutary filaments, minerals, and vitamins are abundant in cowpea seeds, leaves, and green capsules. Cowpea is a water insufficiency tolerant crop that could be used as food for humans and feed for beast with the bulk of their macro and micronutrients. It also contains anti-nutritional rudiments that could be inconvenient to mortal and non-ruminant beast nutrition. still, colorful processing styles are employed to dwindle or exclude the negative goods of anti-nutritional factors. Ruminants consume cowpea seeds for over to 30 of their diets. Raw cowpea seeds, for illustration, are included in the nutrition of ruminants, but they shouldn't be used innon-ruminant diets without treatment. Its shells are a low- cost prospective feed for funk diets, with a maximum use of 15 in starter and finisher sections. Cowpea leaves and green capsules are used to control or treat a variety of mortal conditions, including measles, smallpox, adenitis, becks , and ulcers, in addition to their nutritive benefits. also, the seeds of the cowpea factory are important for the drug of different conditions, similar as tangy, antipyretic, and diuretic. For liver and spleen problems, intestinal cramp, leucorrhoea, menstrual abnormalities, and urine expatriations, decoction or haze is employed. Cowpea may also fix up to 80 of the nitrogen in the soil, lowering the demand for and expenditure of nitrogen toxin. Generally, cowpea shops and their by- products are important for less- precious protein- grounded mortal and beast diets for less developed countries' livelihoods.

Keywords: Cowpea; Feed; Food; Nutritional use

Introduction

Cowpea (Vigna unguiculata L. Walp) is a centuries-old human crop, having originated in Africa and spread throughout Latin America and Southeast Asia [1, 2]. It's a warm-season, vascular annual pulse crop with a wide range of uses. It is a member of the Fabaceae family, subtribe Phaeseolinae, Vigna genus, and Catjang section. The V. unguiculata subspecies unguiculata is responsible for all cultivated cowpeas [3]. The black-eyed pea, black-eyed bean, Crowder pea, Southern pea, frijol caup, and feijo-caup are all names for this legume crop. Africans have been domesticating and farming cowpeas for decades to get protein for themselves and their livestock feed. It's currently grown throughout the world, with a particular emphasis on the tropics [4]. The cowpea grows best in plains foliage, with temperatures ranging from 25 to 35° Celsius and annual rainfall ranging from 750 to 1100 mm. It is more resistant to sandy soils and drought than soybeans. It may grow in a variety of soil types, as long as they are well-drained [5]. Its output has increased 2.7 times since 2000, reaching 8.9 million metric tons in 2019. Nigeria, Niger, and Burkina Faso accounted for 74.3% of all African cowpea production. For almost 6000 years, the cowpea has been widely used as a primary and less-priced protein source throughout Africa. It has gradually made its way into people's diets all over the world.

Alternatively, cowpea is a vital pulse crop for food security and population health around the globe with major nutritional and nutraceutical qualities. In less developed regions, it is primarily planted for grain and leaves, and occasionally for green pods. It is the most important source of macro and micronutrients in the human diet. It can be found in a variety of cuisines and snacks. It can also be eaten whole, tinned, or frozen, as well as mashed into flour for baking purposes. Cowpea seeds have been shown to be a better substitute for soybeans in diets with comparable protein content for those who are allergic to them. Cowpea whole grains and decorticated grains are high in protein, carbs, and fiber, and leaves and green pods have substantial vitamins and minerals [5]. By providing ground cover, fixing nitrogen up to 80%, controlling weeds, and reducing the need for and cost of nitrogen fertilizer, the cowpea plant contributes significantly to the long-term viability of agricultural systems and the development of soil fertility in marginal lands. It is an essential buddy crop for cereal-pulse cropping as it provides residual nitrogen acquired from the decomposition of its foliage litter, roots, and nodes.

Cowpea whole grains have comparable dietary components to other legumes, with a little fat content and enormous protein value. It contains 23–32% protein, 50–60% carbohydrates, and 1% fat. It has 2 to 4 times more protein than cereal and root crops, and it is high in lysine. It has a reasonable amount of dietary fiber, phytochemicals, minerals, and vitamins. While cowpea whole grain protein content is low in methionine and cysteine as compared to livestock-origin proteins, it is high in amino acids as compared to cereals [6, 7]. According to several researchers, cowpea seeds, leaves or aerial parts, hay, and haulms are also suitable fodder species that are necessary for livestock

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feed. Low animal production is typically connected to less palatability and nitrogen content of accessible feeds in several tropical and subtropical locations. As a result, several high-yielding tropical grain legumes, such as cowpea, could be used as animal feed [8]. The seed's mean protein content is 25.47%, which is comparable to soybeans, winged beans, and gram. As compared to Cajanus cajan (Arhar) and gram pulse, cowpea seeds have a higher lysine concentration [9]. Cowpea plant components (for example, leaves, green pods) are used to prevent or treat several human ailments such as measles, smallpox, adenitis, burns, and ulcers, in addition to their nutritional value. Similarly, the seeds of cowpea are used to cure several ailments, such as astringent, antipyretic, and diuretic. For liver and spleen problems, intestinal cramp, leucorrhoea, menstrual abnormalities, and urine expulsions, decoction or soup is employed [10].

Meanwhile, demand for animal-derived proteins, vitamins, and a critical mineral has risen, and their cost has also increased from time to time. To overcome such a problem, legumes like cowpea could enhance human and animal feed accessibility and protein absorption [11]. For example, cowpea seeds and leaves are a valuable source of protein, vitamins, and minerals in less developed places, and they are less expensive than beef, dairy products, seafood, fish, meat, or poultry, helping low-income farmers by combating protein malnutrition. Many sections of Africa ingest ripe or immature pods, especially during the "hungry period". Furthermore, despite the fact that cowpea seeds, leaves, and other its plant parts have significant value for population health, food, and feed for underdeveloped nations, as mentioned earlier, it is the least used pulse crop in comparison to others, such as soybeans, and it has received less attention from international researchers [12]. In this regard, research has been undertaken in various regions of the world to study the nutritional composition of cowpea seeds and leaves. However, the nutritional benefit of cowpea seeds and leaves in human and animal diets has not been thoroughly researched or mixed. Therefore, the goal of this comprehensive analysis was to provide insight and synthesis into the nutritional uses of cowpea for human consumption and livestock feed, with the specific objectives: a) to describe the nutritional value of cowpea as a food source. b) To determine the nutritional value of cowpea as a feed source. c) To identify the health benefits of cowpea. This review's information was gathered from secondary sources such as relevant books, scientific publications, and internet sources. After gathering all the available information, it was presented in accordance with the objectives of this paper [13].

Materials and Methods

Material

All of the experiments used four local cowpea varieties grown in the Northeast of Argentina (NEA): Cuarenton (CU), Colorado (CO), San Francisco (SF), and Z1, which were obtained from the Experimental El Sombrero-Corrientes (INTA) (crops 2009). Until they could be used, cowpea seeds were kept in a 500 g hermetic container at 10 °C.

Methods of processing: Soaking: The cowpeas were submerged in sodium bicarbonate solutions (0.02 g/100 mL; pH 8.3) using a seed-to-liquid ratio of 1:10 (g:) for 120, 240, and 360 minutes mL).

Cooking: In a condenser-equipped beaker, cowpeas were cooked in boiling water for 20, 40, and 60 minutes at a seed-to-distilled water ratio of 1:10 (g: mL).

Autoclaving: At 121 °C, cowpeas were cooked under pressure (2.175 kPa) for 10, 20, and 30 minutes with a seed-to-distilled water ratio of 1:10 (g: mL).

After being washed with distilled water, each of the processed samples was dried to a constant weight in an oven at 55 °C. Each processing step was done three times.

Preparation of the seed flour Both treated and untreated cowpeas (with or without a seed coat) were ground in an electric mill (Braun KSM2 model, coffee grinder, Mexico, 2006), and then they were sieved through an 80 ASTM (177 m) mesh.

SDS-PAGE (Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis) was performed on all gels in Bio-Rad Mini Protean II Model minislabs. Using continuous gels (12%), Laemmli's method from 1970 for SDS-PAGE was used. Centrifuged at 15,800 g for five minutes at 4 °C, protein samples (10 mg/mL) were dissolved in 0.125 mol/L Tris–HCl, pH 6.8, 20 mL/100 mL glycerol, 0.1 g/100 mL SDS, and 0.05 g/100 mL bromophenol blue. The gel was loaded with supernatants (30–40 g of protein per lane). Before centrifugation, samples that were going to be run under reducing conditions were boiled for one minute in sample buffer containing 5 mL/100 mL 2-mercaptoethanol (2-ME). The following molecular weight standards were used to estimate the molecular masses of polypeptides during electrophoresis, which was carried out for one hour at a constant voltage of 200 V: 94 kDa phosphorylase B; 67 kDa bovine serum albumin; 45 kDa ovalbumin; 30 kDa carbonic anhydrase; inhibitor of trypsin (20,1 kDa); -lactalbumin (Pharmacia), which has 14.4 kDa.

Pounded samples were used to estimate the in vitro mineral availability (A) of iron (AFe, g/100 g), zinc (AZn, g/100 g), calcium (ACa, g/100 g), and magnesium (AMg, g/100 g). The dialysate's mineral content, expressed as a percentage of the total sample's iron, zinc, calcium, and magnesium, was used to calculate the minerals' availability.

2.8. The modified multienzyme technique was used to evaluate the raw treated and untreated cowpeas' in vitro protein digestibility (IVPD). The following formula was used to determine in vitro protein digestibility: %IVPD=234.8422.56x, where x is the pH after 20 minutes of incubation. This method works on the premise that four proteolytic enzymes are used to digest the protein, and the release of amino acids at predetermined intervals causes the pH to change.

A Q100 V9.8 Build 296 calorimeter made by TA Instrument and located in New Castle, Delaware, United States, was used for differential scanning calorimetry (DSC) thermal analysis. Using indium, lauric acid, and stearic acid (pro-analysis) as standards, the apparatus was calibrated at a heating rate of 10 °C/min. Aluminum pans with hermetic seals were made to hold 12–15 mg of freeze-dried flours suspended in water (40 g/100 mL) for the preparation. From 25 to 130 °C, samples were scanned at 10 °C/min. A lead-sealed double-empty pan served as a reference. The pans were punctured after each run, and the dry matter content was determined by overnighting them in an oven at 105 °C. The enthalpy of transition, H (J/g dry solids flour), and the denaturation temperature, Td (°C), were determined by analyzing the thermograms with Analysis V4.2E (TA Instruments, New Castle, Delaware, USA, 2005).

Results and Discussion

Chemical makeup

The raw seeds of four cowpea varieties are shown to have the same chemical makeup. Z1 had more protein than CU and SF, but it was similar to CO, while CO's protein content was not significantly different from CU and SF's (P 0.05). The CU, CO, and Z1 varieties had the most

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carbohydrates, while SF had the least (P 0.05). CO, SF, and Z1 all had significantly different moisture content (P 0.05), but CU was the same as SF and CO. In terms of ash and gross fiber content, there were no significant differences between varieties (P > 0.05). All of the nutrients' values are consistent with those that have been previously reported by other authors. In contrast, two cowpea varieties from Egypt and Canada had higher carbohydrates (65.89–68.96 g/100 g) and lower ash (2.84–3.27 g/100 g).

Effects of thermal treatments.

Protein electrophoresis CO and CU samples were chosen for analysis because of their high initial nutritional content, low anti-nutrient content, and significant decrease in these parameters when subjected to thermal treatment. In contrast, small and medium-sized farmers in the NEA were more accepting of the CO and CU varieties than of the other varieties.

The polypeptide composition of CO native flour and CU native flour was identical. The polypeptide composition of both varieties was identical in response to both thermal and non-thermal treatments. As a result, only the CU variety is available.

Polypeptides with molecular weights of less than 28 kDa were found in non-reductively analyzed native flours with molecular weights of 94, 80, 60, 56, 52, 42, and 32. Except for high-molecular-weight polypeptides (94 and 80 kDa), these findings are comparable to those of, who observed gel bands ranging from 40 to 66.2 kDa (40, 60, and 66.2 kDa) in cowpea protein fractions. According to, cowpea protein fractions and vicilins displayed two bands of 52 and 50 kDa, respectively, in accordance with this. Based on information from other authors, these values are within the kDa range of the 7S storage globulin.

Treatments had an impact on both reducing and non-reducing conditions. Under either reducing or non-reducing conditions, the polypeptide composition of soaked flours and non-soaked flours was identical.

Band intensity decreased slightly in non-reducing flours after short cooking times, but more pronouncedly after longer cooking times for flours. Autoclaving for a short time had the same effect as cooking for a long time. However, compared to untreated or other thermally treated samples, the intensity of the 28 kDa polypeptide increased and polypeptides of 94, 80, 60, 42, and 28 kDa disappeared under more severe autoclaving conditions. This could be due to polypeptide dissociation as a result of the severe thermal treatment or the formation of high molecular weight aggregates that do not enter the gel. The 80 kDa polypeptide that indicates the presence of disulphide bridges was not present in untreated flours when reduced. The remaining polypeptides, on the other hand, were identical to those found under non-reducing conditions. Similar to what was observed under non-reducing conditions, both thermal treatments resulted in the disappearance of polypeptides of 94 and 42 kDa. High molecular weight protein aggregates contained both 94 and 42 kDa polypeptides.

With thermal treatment (cooking and autoclaving), the protein and carbohydrate content generally decreased, but to a lesser extent than the anti-nutrients. For all cowpea varieties, the autoclaving (121 °C, 30 min) protein reduction was 0.3%–7%, while the cooking (100 °C, 60 min) protein reduction was 3%–6%, with Z1 being more affected. On the other hand, the reduction in carbohydrates for the SF and CU varieties was greater (around 35%) with both thermal treatments (cooking for 60 minutes and autoclaving for 30 minutes), but not for all CO and SF treatments. The partial oxidation of some amino acids, such as tyr and his, as well as other nitrogenous compounds, could be the cause of the loss of proteins and other nitrogen compounds during thermal treatment. However, the solubilization of the soluble starch in legumes during cooking is responsible for the reduction in carbohydrates.

The SF variety had the highest initial levels of polyphenols and tannin, while the CU variety had the lowest. The polyphenol, tannin, and phytic acid content of flours obtained by seed soaking decreased significantly (P 0.05) compared to those obtained by cooking or autoclaving. These findings are consistent with earlier reports of Vigna acantofilia and V. sinensis. The soaking process's ability to create an ionic environment may have resulted in the loss of polyphenols in the seeds. The seed coat's permeability may also be affected by the altered ionic environment. As a result, solid losses can grow more quickly.

Cooking and autoclaving reduced the amount of polyphenols, particularly in CU and SF varieties, by 50 to 65 percent. Tannin levels decreased in all varieties, with the exception of CO, under the same conditions by 55%–71%. The tannin molecules' heat-induced degradation and solubilization in water may be the cause of this decrease in total phenols. When cowpea seeds were subjected to severe thermal treatments (cooking for 60 minutes and autoclaving for 30 minutes), there was a significant decrease in the amount of polyphenol (58–82 percent) and tannin (79 percent), which may have been caused by the tannins binding to proteins and other organic substances during cooking. Despite the fact that autoclaving resulted in a greater reduction of polyphenol and tannin content than the cooking treatment, our findings are close to these values [13].

The CO variety had the highest initial phytic acid content, with 0.51 g of phytic acid per 100 g of dry solids, while the Z1, SF, and CU varieties had values of 0.42, 0.36, and 0.37 g, respectively. Raw V. sinensis seeds produced outcomes that were compared to one another. In the current study, soaking treatment resulted in a small but significant drop in phytic acid content (10–20%). On the other hand, all varieties showed a phytic acid reduction of 35%–50% with cooking and 40%–55% with autoclave treatment. Another variety of cowpeas shows a similar (50 percent) reduction in phytic acid content when cooked. Phytic acid content in cowpea seeds, on the other hand, was found to be slightly lower after thermal treatments. The hydrolysis by phytases during soaking may be the cause of the decrease in phytic acid. Additionally, phytic acid can form insoluble complexes with other components (calcium, magnesium, and proteins) and is sensitive to thermal treatment [14].

Minerals

Among the four cowpea varieties that were examined, native flours of CU contained the most P (0.862 g/100 g dry solids) and Zn (30.640 mg/kg dry solids), respectively. Z1 variety had a significant amount of potassium (0.762 g/100 g dry solids), while CO variety had the highest iron content (19.030 mg/kg dry solids). In addition, the levels of zinc and iron in all cowpea varieties were lower than those reported.

Conclusion

All of the varieties examined shared a similar amount of protein. The SF variety had the fewest carbohydrates. The SF, Z1, and CO varieties had the highest polyphenol, tannin, and phytic acid content, respectively. In contrast, the CU variety had the lowest anti-nutritional factors.

Because they contributed the most to the first principal component of the PC analysis, anti-nutrient content enabled treatment

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differentiation for each variety. However, proteins and carbohydrates had no significant impact on treatment differentiation and behaved similarly for each variety. The untreated flour—also known as native flour—had the highest concentration of anti-nutrients—tannins, polyphenols, and phytic acid—in all varieties. The effect of processing on the flour varies by variety. The majority of varieties' cooking and soaking processing times exhibit anti-nutrient behavior that is intermediate between autoclaving and the native compound. The cowpea seeds' nutritional value could be increased by employing these simple, low-cost processing methods.

Starch and protein, the main chemical components of cowpea flour, are significant predictors of H. During the thermal processing of cowpea seeds, protein denaturation and starch gelatinization appear to be significant modifications. Due to its connection to a number of quality parameters of products that contain the flour, the transition enthalpy H has the potential to become an important functional index for cowpea flour.

Cowpea seed varieties, particularly CO and CU, could be used as a low-cost alternative protein source for food formulas due to their nutritional and antinutritional behavior under thermal treatments.

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Conflict of Interest

None

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