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An Alternative Processed Meat Product (Luncheon) for Acute Kidney Disease

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Abstract

The study aims to develop alternative processed meat products for individuals with acute kidney disease, focusing on vegetarian and fabricated luncheon options. Analyzing the chemical composition, it was found that the prepared luncheons had higher moisture, protein, and ash. The study analyzed the effects of a luncheon on kidney health in 54 male Sprague-Dawley rats, divided into nine groups. Group 1 rats were given a standard diet; group 2 received a positive control supplemented with ethylene glycol; Group 3 received a low-protein diet with 7% protein and 1% ethylene glycol. Groups (4, 5, and 6), and groups (7, 8, and 9) were given the positive control diet combined with the prepared luncheon and commercial luncheon at levels of 10%, 20%, and 30%, respectively. The study revealed a significant increase in lipid peroxidation, albumin and total protein levels in groups supplemented with 20% and 30% commercial luncheon. The prepared luncheon improved serum creatinine and urea values, leading to normalization. The commercial luncheon groups showing a significant weight reduction. The study emphasizes the potential of luncheon-based alternative processed meat products, particularly in supporting kidney health*Keyword*: Processed meat product, Chronic kidney disease, Nutritional management in CKD, Vegetarian diet, Low protein diet.

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1. Introduction

Kidney failure disease has become a national problem among the chronic diseases that Egyptians suffer from, and it is increasing dangerously in Egyptian society. The number of people with kidney failure has reached 52 thousand patients in all governorates, according to the official statistics of the Ministry of Health [1]. This is in addition to the fact that there are 9 million Egyptians who carry risk factors and have stages of kidney failure. In 2019, the 10 leading causes of death were responsible for 55% of the 55.4 million deaths worldwide. Kidney disease has moved from the thirteenth leading cause of death in the world to the tenth. The death rate from it increased from 813,000 in 2000 to 1.3 million in 2019 [2]. Acute Kidney Injury (AKI) occurs when the kidneys suddenly become unable to filter waste products from the blood, leading to their accumulation at dangerous levels that may disturb the chemical composition of the blood, and the main causes of infection can lead to slow blood flow to the kidneys, direct kidney damage, blockage of the ureters, or the body not excreting waste products through urine [3].

Although "acute renal failure" may cause complications that lead to the death of the patient, it is treatable if it is dealt with quickly and the main cause of infection is treated. If toxins accumulate in the blood, temporary hemodialysis can be resorted to. Acute renal failure can turn into chronic renal failure, a kidney disease that results in the kidney losing all of its basic functions, especially its ability to return water and essential minerals to the body, and purify the blood of various impurities.

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Chronic kidney disease (CKD) is divided into five stages and is determined on the basis of the presence of kidney damage, the level of kidney function and the glomerular filtration rate (GFR). There are also risk factors that cause kidney failure, including high pressure, diabetes, obesity and anemia, in addition to the presence of other diseases such as stones and genetic factors, including, for example, kidney atrophy or defects in the urinary tract and ureters, in addition to environmental causes such as random drug use and pesticides. Kidney failure may appear acute or develop with time into chronic kidney disease, and the need for nutritional therapy and renal filtration or kidney transplantation becomes a necessity to preserve the patient's life [4]. Both types need therapeutic nutrition intervention, as nutritional therapy may restore the kidney function of a severe renal failure patient.

Therapeutic nutrition for kidney disease aims to reduce the excretory burden of the kidneys, by restricting dietary protein, which is the mainstay of nutritional therapy for chronic kidney disease. Most of these patients may not need the renal filtration process if they can control the progression of the disease through dietary regulation. It is also known that in patients with end-stage renal disease (ESRD) abnormal fatty acid imbalance occurs and symptoms associated with essential fatty acid deficiency such as itching, abnormal sweating, delayed wound healing, increased susceptibility to infection, anemia and increased hemolysis, therefore, supplemental use appears to be essential fatty acids and their derivatives may offer multiple health benefits to ESRD patients, and positively affect cell membrane structure and physiological features.

Omega-3 fatty acids also have anti-inflammatory effects for many inflammatory disorders, which is why it is recommended to take nutritional supplements such as fish oil rich in omega-3 fatty acids useful in relieving itching. Omega-3 fatty acids are widely used to manage disease and complications. Patients with end-stage renal disease do not receive enough omega-3 fatty acids due to limited consumption of rich food of omega-3 fatty acids, such as nuts and fishes. Recent studies have indicated that short- or long-term intervention with omega-3 fatty acids might reduce the risk of end-stage renal disease and proteinuria and increase the creatinine clearance rate [5].

Meat is a high biological protein source not only for its nutritional properties but also for its great favorite. It is considered the first choice for animal protein sources. Meat is consumed either as an ingredient in food preparation or as processed meat products. Although processed meat products are gaining popularity worldwide and the volume of consumption is raising [6]. Processed meat intake is associated with health risks and often involves nitrites that may form cancer-causing N-nitroso. It also involves adding high amounts of salt and fat. However, Meat luncheon is one of the most acceptable food products and widely consumed used for fast meats, it generally containing finely chopped meat and high saturated fat with spices, salt, nitrite which not suitable kidney disease patients [7].

However, from a health point of view, it cannot be recommended to eat meat and its processed products especially for some categories such as kidney patients due to their high protein content and unhealthy fats. There is now a global trend to search for healthy natural products as an alternative to food products, especially food additives with health problems. Therefore, finding alternative solutions to meat is the best solution for these groups.

2. Materials and Methods

2.1 Raw materials: The majority of the components such as corn starch, oil, egg, sucrose for diet ingredients used in preparing the formulated rat diets were procured from the local market. Additionally, garlic and red pepper oil were obtained from Agricultural Research Center, Giza, Egypt, and encapsulated through a spray drying unit at the National Research Centre.

2.2 Other materials: Animals; Rats were obtained from National Research Center, Dokki, Egypt. Blood hemoglobin, liver function, kidney function and albumin, total protein kits were obtained from; Spectrum and Biomed companies respectively.

2.3 Methods

2.3.1.Encapsulation of Oil: A functional oil rich in omega-3 sources was selected to complement the flavor and taste of the final product. The incorporation of functional oils into the product and their encapsulation followed the procedure outlined by Edris et al. [8]. The co-current Mini Spray Dryer B-290 (Büchi, Flawil, Switzerland) was used. The extracted oils were coated by spray drying by adding of oil emulsion and maltodextrin (MD) as a polymer. The dimensions of the glass dryer chamber were 0.45 m in height and 0.14 m in diameter. The spraying system consisted of a two-fluid nozzle composed of an internal tip with an opening of 0.7 mm in diameter and an external ring with an opening of 1.5 mm in diameter. Moreover, the constant process parameters included a drying air flow rate of 85.0% of the suction fan controller. The inlet and outlet temperatures were 160.0EC and 80.0EC (±1.0EC), respectively. Furthermore, the resulted powder was collected from the drying chamber wall and the cyclone and the drying process was conducted twice for two different batches of each oil emulsion.

2.3.2.Product Preparation: The luncheon was crafted using a traditional approach, as outlined by Keeton [9] with adaptations tailored to the specific dietary needs of renal patients requiring a low-protein diet and suits lacto-ovo vegetarianism. The natural and healthful ingredients included flour, a blend of various grains, eggs, flavor-enhancing additives, and natural colors derived from fresh vegetables. Additionally, capsulated oils were incorporated to enhance flavor. Photo.1 shows the image of the prepared luncheon.

Photo 1: Prepared Luncheon

2.3.2.1.Chemical Characterization of Luncheon Chemical analysis of luncheon samples was conducted following the procedures outlined in AOAC [10] for determining protein, fat, moisture and ash contents.

2.3.3.Experimental Design: This investigation involved 54 male Sprague Dawley rats with a body weight of 150 ±10 g. The rats were accommodated in hygienic conditions within metabolic stainless-steel cages at a room temperature of 24±3 °C. They had ad-libitum access to food and water throughout the study. The study proposal received approval from the Scientific Committee at the National Research Centre, Egypt.

2.3.3.1. Experimental Design and Diet Preparation: The experimental rats were allocated into 9 groups, each consisting of 6 rats. The rat diets were meticulously prepared and categorized as follows: Group 1, the negative control, was fed a basal diet that was semi-synthetic and nutritionally completes (AIN-93 G); the vitamins and minerals mixtures were prepared according to the specifications outlined by Reeves et al. [11]. Group 2, the positive control (1), were fed a basal diet supplemented with 1% ethylene glycol, following the design proposed by Depass et al. [12] with slight modifications. Group 3, the positive control (2), involved rats consuming a diet containing 7% protein (low protein diet) along with 1% ethylene glycol. Groups 4, 5, and 6 were fed the positive control group (2) mixed with prepared luncheon at levels of 10%, 20%, and 30%, respectively. Similarly, Groups 7, 8, and 9 were fed the positive control group (2) mixed with commercial luncheon at levels of 10%, 20%, and 30%, respectively.

All diets maintained consistent levels of vitamins, minerals, and fiber throughout the 6-week experimental period. Weekly records were maintained for both body weight and food intake. Upon completion of the experiment, the rats were anesthetized, blood samples were collected, and stored at -70 °C until biochemical analysis.

2.3.3.2.Nutritional Evaluation: To assess the nutritional aspects of the diets, various parameters were determined, including feed intake, body weight gain (BWG %), feed efficiency ratio (FER), and organ weight (%), as well as body weight (%). The evaluation followed the methodology outlined by Chapman et al. [13].

2.3.3.3Biochemical Analysis: For liver function assessment, the activities of AST and ALT were determined calorimetrically using the method outlined by Reitman and Frankel [14]. Serum albumin levels were measured following the procedure by Doumas et al. [15]. Total protein levels were determined. In assessing kidney function, urea levels were estimated as described by Fawcett and Scott [16], and creatinine levels were determined according to Bartels et al. [17]. Uric acid levels were also measured. Additionally, lipid peroxides were estimated following the procedure outlined by Ohkawa et al. [18]. Blood hemoglobin levels were determined using the colorimetric method as described by Tietz [19].

2.3.4.Statistical Analysis: The data were expressed as mean ± standard deviation (S.D.). Statistical analyses were conducted using the SPSS computer program (GraphPad Software Inc, San Diego, CA, USA). One-way analysis of variance (ANOVA) was performed, followed by Duncan's multiple tests. A significance level of $P \leq 0.05$ was considered statistically significant.

3. Results and Discussion

3.1.Analysis of Chemical Composition in Alternative Processed Meat Product

Luncheon, a well-known preserved meat, holds a special place among ready-to-eat meat products. One variant, beef luncheon, is particularly renowned for its high biological value and widespread demand. The preparation of luncheon meat involves finely chopped meat and fat, often supplemented with grains. To enhance its flavor, it undergoes treatment with spices, salt, nitrite, and heat processing. The pricing of luncheon meat usually varies depending on the inclusion of flavor additives, spices, and the proportion of lean meat used.

Despite these variations, luncheon meat remains a highly accepted food product, largely embraced for its convenience and rapid preparation, making it a popular choice among consumers [20]. However, the consumption of processed meat has often been associated with health risks, primarily attributed to the presence of nitrites, which have the potential to contribute to cancer development. Additionally, processed meat products commonly incorporate varying amounts of salt. To understand the composition of luncheon meat, we compare the chemical analysis results of traditional Egyptian luncheon with an alternative processed meat, as outlined in Table 1. According to the Egyptian Standard Specification (ESS), the expected protein and fat content in Egyptian luncheon is approximately 35%, with a minimum of 15% for protein and 30% for fat. However, upon comparing the obtained data, it is evident that the commercial sample deviates from the E.S.S guidelines (2005/1114) outlined by Mahmoud et al. [21].

Table 1: Chemical analysis for traditional Egyptian luncheon and An Alternative processed Meat

	Moisture %	Fat %	Protein %	Ash %
Commercial luncheon	72.77	15.69	7.8	3.74
Prepared luncheon	76.49	7.95	10.98	4.58

This deviation may stem from the common practice among meat processors, who often use improper meat cuts, beef trimmings, or meat substitute materials containing non-meat components that are relatively more cost-effective than actual meat. Interestingly, these findings align with a study conducted by Elbazidy et al. [22], which investigated 800 traditional Egyptian beef luncheon samples. Another study examining twenty different traditional Egyptian luncheon samples found that some samples matched the E.S.S's recommended protein percentage range of approximately 15-28%. However, the fat content in these samples ranged from approximately 4-9%, as reported by Maky et al. [23].

Numerous studies have explored the controversial relationship between dietary protein restriction and plant-based diets in the context of chronic kidney disease (CKD) progression Chauveau et al.[24]. Some authors argue against the amalgamation of plant-based diets and kidney disease, citing concerns about the high potassium and phosphorus content associated with vegetarianism, which may be inconvenient for CKD patients Gluba-Brzózka et al.[25].

To address the nutritional needs of individuals with CKD, alternatives to animal-based protein sources should be considered. One such alternative is quinoa. Known for its high biological value, quinoa offers essential amino acids in proportions comparable to those found in beef. Recognizing its nutritional adequacy, the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) acknowledge that quinoa fulfills the amino acid requirements for adults, positioning it as a valuable protein source in the diet Gordillo-Bastidas, [26].

Quinoa possesses a total lipid content of 14.5%, with the majority, approximately 70-89.4%, comprising unsaturated fats. Among these unsaturated fats, it includes 38.9-57% linoleic acid, 24-27.7% oleic acid, and 4% α-linolenic acid. Notably, quinoa incorporates vitamin E, which aids in safeguarding the unsaturated fatty acid content within the plant. The Omega-6 to Omega-3 ratio in quinoa is approximately 6:1 (Mohamed et al. [27]. This nutritional profile suggests potential benefits as ω3 fatty acids are thought to play a role in preventing or slowing down the decline of kidney function. Research indicates that older adults consuming higher amounts of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) exhibit a 32% lower prevalence of chronic kidney disease (CKD) compared to those with lower intake, as demonstrated by Hoogeveen et al. [28] in 2014.

In addition to quinoa, capsulated red pepper and garlic oil also provide health benefits. The analysis of fatty acid composition and the identification of volatile components in these oils revealed that the total unsaturated fatty acids ranged from 86.39% to 91.04%, while the saturated fatty acids remained at a low percentage, not exceeding 13.61%. Linolenic acid, an ω3 fatty acid associated with kidney protection and immune function support, was present at 15.2% El Haggar et al. [29].

Considering all these findings, it is clear that incorporating omega-3 fatty acids through dietary sources or supplementation can alleviate the severity of chronic kidney disease (CKD) among individuals diagnosed with the condition. Furthermore, the positive influence of omega-3 in fortifying immunity and enhancing mental well-being has also been underscored by Li et al. [30]. Omega-3 fatty acids have the potential to reduce the production of pro-inflammatory cytokines and thereby mitigate viral entry and bolster immune function. the analysis of the chemical composition in alternative processed meat products sheds light on the variations and deviations from established guidelines. Luncheon meat, although widely accepted and convenient, may carry health risks due to the presence of nitrites and varying salt amounts. Exploring alternative sources of protein, such as quinoa, can provide nutritional adequacy without compromising dietary restrictions for individuals with chronic kidney disease. Additionally, the incorporation of omega-3 fatty acids through sources like capsulated red pepper and garlic oil can offer additional health benefits.

3.2.Biochemical Analysis of Alternative processed Meat Product

Figure 1 provides an illustration of the results obtained from analyzing serum malondialdehyde (MDA) levels in rats that were fed different meat products. The study compared the effects of a diet containing 7% low protein and prepared luncheon with a diet containing a commercial luncheon product. The findings showed that rats on a diet with prepared luncheon exhibited lower levels of lipid peroxidation, as indicated by a decrease in MDA, compared to those on a diet with the commercial product. The groups that received commercial luncheon supplemented with 20% and 30% showed a significant increase in MDA levels, with values of 0.91±0.038 and 0.97±0.018, respectively. However, no significant difference was observed between the prepared luncheon groups with 20% and 30% supplementation and the commercial luncheon group with 10% addition. The MDA values for these groups were 0.83±0.017, 0.85±0.012, and 0.86±0.020, respectively. Serum MDA serves as a specific marker for lipid peroxidation, which is a process involving the oxidation of polyunsaturated fatty acids. This oxidative process can lead to significant tissue damage, as lipids are integral components of cellular membranes. Malondialdehyde, a byproduct of lipid peroxidation, possesses the capability to attack macromolecules and induce alterations in their functions. Elevated serum MDA levels have been observed in individuals with chronic kidney disease (CKD), indicating an association between lipid peroxidation and the pathogenesis of CKD and its related complications. The increased oxidative stress and potential damage to cellular components in CKD patients may be attributed to elevated serum MDA levels Hojs et al. [31].

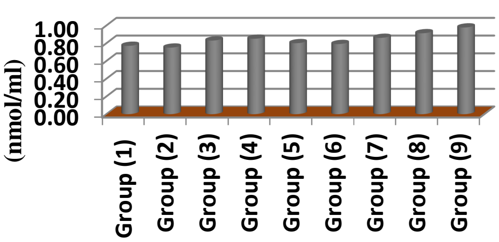

Figure 1: Effect of low protein diet with prepared and commercial luncheon with different additions 10, 20, and 30% on lipid peroxidation (MDA)

Figure 2 depicts the results for albumin and total protein levels in rats that were fed different meat products. The study compared the effects of a low protein diet (LPD) and prepared luncheon with a commercial luncheon product. Significant differences were observed in albumin and total protein levels between the commercial product groups and the remaining groups. The highest values were recorded in Group 9, which received a 7% low protein diet and 30% commercial luncheon supplementation, with albumin and total protein values of 5.320±0.125 and 6.47±0.095, respectively. No significant differences were observed between the prepared product groups and the negative control groups. Previous studies have shown the potential of a low protein diet in slowing the progression of kidney disease and managing its complications. This aligns with the findings of Elshahat et al. [32], who recommended LPD recommendations ranging between 6-8% protein for effective CKD management. The alternative processed meat product containing approximately 7% protein emerges as a beneficial option in CKD management, as it aids in reducing proteinuria levels, improving blood pressure control, and correcting metabolic acidosis. Other studies focusing on CKD management have also recommended a low-protein diet as a valuable strategy to slow disease progression and delay the need for dialysis Foreman et al. [33].

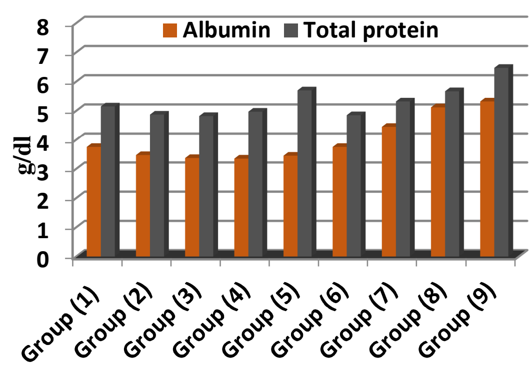

Figure 2: Effect of low protein diet with prepared and commercial luncheon with different additions 10, 20, and 30% on albumin and total protein

The results illustrated in Figures 3, 4, and 5 demonstrate a correlation between weight status and the severity of impaired kidney and liver functions within the commercial luncheon groups. These figures present laboratory investigations of ALT and AST levels (expressed in U/L) across different groups. Significantly elevated ALT and AST levels were observed in the group that received commercial luncheon with 30% supplementation, recording values of 75.58±3.4 and 199±1.8, respectively, compared to the other groups. On the other hand, an improvement in serum creatinine and urea values was observed in response to the consumption of prepared luncheon. These values moved towards normalization, indicating a positive impact on kidney function.

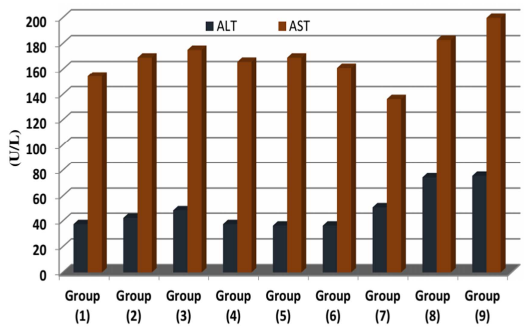

Figure 3: Effect of low protein diet with prepared and commercial luncheon with different additions 10, 20, and 30% on ALT and AST

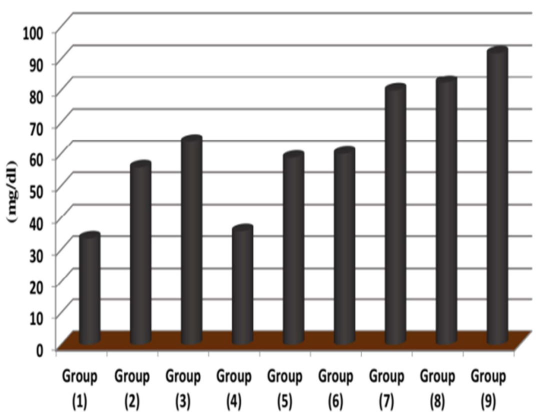

Figure 4: Effect of low protein diet with prepared and commercial luncheon with different additions 10, 20, and 30% on urea

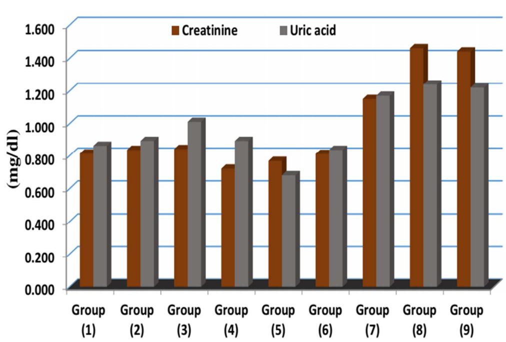

Figure 5. Effect of low protein diet with prepared and commercial luncheon with different additions 10, 20, and 30% on uric acid and creatinine.

3.3. Nutritional evaluation of Alternative processed Meat Product

In this study, the nutritional evaluation of an alternative processed meat product was conducted using experimental rats, to assess the impact of both prepared and commercial luncheon on body weight. The results showed a significant reduction in weight among the groups receiving commercial luncheon. The most substantial weight loss was observed in the commercial luncheon groups at the 30% supplementation level, with an average weight of 133±6.51. On the other hand, rats fed a diet containing 1% ethylene glycol and prepared luncheon supplemented with 20% and 30% showed a corrective influence on body weight. The respective weights were 163±4.56 and 165±3.67.

Figure 6 illustrates the initial and final body weights recorded during the experiment. It's important to note that weight loss has been recognized to enhance overall kidney function and reduce proteinuria levels. However, caution should be exercised as sarcopenia, the loss of muscle mass, can pose risks. A study by Massini et al. [34] reported that individuals experiencing rapid weight loss with chronic kidney disease tend to exhibit a disproportionately higher loss of lean body mass than fat mass. Losing fat mass, while effective in decreasing blood pressure, can have adverse effects during swift weight loss. Sarcopenia, influenced by various factors and dependent on the type of kidney disease, is prevalent and associated with increased [35]. In line with the observations of Kim et al. [36]. The reduction in body weight observed in this study may be attributed to the reflex response to ethylene glycol.

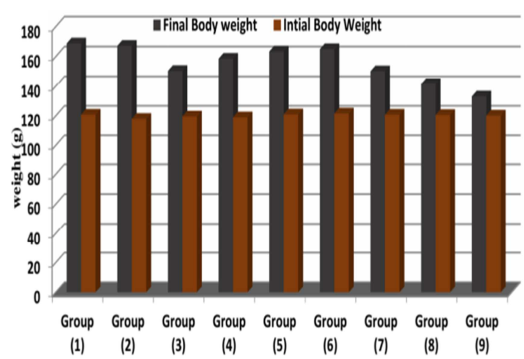

Figure 6: Effect of low protein diet with prepared and commercial luncheon with different additions 10, 20, and 30% on body weight

4. Conclusions

This study provides important insights into the development of alternative processed meat products, specifically luncheon, suitable for individuals with acute kidney disease. Incorporating a diverse range of protein sources in the diets can contribute to better overall health and well-being, also considering the specific dietary requirements of individuals with kidney disease.

5. Conflict of interest

There are no conflicts to declare.

6. References

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