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PRODUCTION, SENSORY EVALUATION AND INSTRUCTIONAL MANUAL DEVELOPMENT FOR HOMEMADE SUYA SPICE IN HOSPITALITY EDUCATION

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ABSTRACT
This study developed and evaluated a homemade suya spice formulation using indigenous Nigerian ingredients and an accompanying instructional manual for hospitality education. Three formulations were prepared from uda, cloves, calabash nutmeg, pepper, dates, ginger, and kuli kuli: F1 (equal proportions), F2 (doubled pepper and ginger), and F3 (doubled uda and calabash nutmeg). Thirty semi-trained panelists evaluated the formulations using a 9-point hedonic scale. F2 achieved the highest overall acceptability (8.2±0.3), significantly outperforming F1 (6.8±0.4) and F3 (7.1±0.3) ($p<0.05$). Based on F2, an instructional manual with six modules was developed following the ADDIE model and evaluated by five hospitality education experts using a 4-point rating scale. The manual received a mean score of 3.68±0.21 (87.6% approval), indicating suitability for hospitality curricula. The findings suggest that homemade suya spice offers a viable alternative to synthetic commercial seasonings, and the instructional manual provides a practical resource for hospitality educators.

Keywords: Suya spice, indigenous spices, sensory evaluation, instructional manual, hospitality education, Nigeria

Introduction

Suya is a traditional grilled meat product originating from the Hausa people of northern Nigeria. It represents one of West Africa's most popular street foods, with an estimated daily consumption exceeding 5 million servings across the region (Olusegun & Adebayo, 2021). The characteristic flavour profile of suya derives from "yaji"—a complex spice blend traditionally incorporating dried peppers, ginger, and local spices including uda (Xylopia aethiopica), calabash nutmeg (Monodora myristica), and cloves (Syzygium aromaticum).

Beyond its culinary appeal, suya supports significant economic activity, providing livelihoods for numerous small-scale processors, vendors, and spice blenders across Nigeria (Ibrahim & Abdulrahman, 2020). However, contemporary commercial suya spice production has shifted from traditional formulations toward synthetic alternatives. Manufacturers increasingly substitute authentic ingredients with monosodium glutamate (MSG), artificial colourants, and bulking agents to reduce costs and extend shelf life (Adeleke & Odedeji, 2020; Santos et al., 2023).

Synthetic Additives in Commercial Seasonings

The widespread use of synthetic additives in commercial seasonings has attracted scholarly attention. Common additives include flavour enhancers (MSG, disodium inosinate, disodium guanylate), anti-caking agents (tricalcium phosphate, silicon dioxide), and preservatives (sodium benzoate, potassium sorbate) (Santos et al., 2023). Adeleke and Odedeji (2020) analysed commercial suya spice samples from southwestern Nigeria and found that 78% contained detectable MSG, while only 12% contained uda or calabash nutmeg. This finding indicates substantial divergence from traditional formulations.

The health implications of these additives remain debated. Regulatory bodies including the U.S. Food and Drug Administration, European Food Safety Authority, and World Health Organization recognize MSG as generally safe at normal consumption levels (WHO, 2023). However, Prabhakar et al. (2025) reported that regular users of MSG-containing seasonings may consume an additional 800–1,200 mg of sodium daily. Since MSG contains only 12% sodium compared to 39% in table salt, some researchers suggest strategic MSG use could support sodium reduction efforts (Prabhakar et al., 2025). The broader concern centres on total sodium intake rather than MSG toxicity per se.

Indigenous Spices as Functional Alternatives

The indigenous spices used in traditional suya possess functional properties that extend beyond flavour contribution. Uda (Xylopia aethiopica) contains essential oils dominated by terpenoids and exhibits antimicrobial activity against foodborne pathogens (Falodun et al., 2019). Cloves (Syzygium aromaticum) provide eugenol, a phenolic compound with antioxidant properties (Cortés-Rojas et al., 2014). Calabash nutmeg (Monodora myristica) yields myristicin and elemicin, compounds associated with flavour complexity (Ogunwande et al., 2018).

Ginger (Zingiber officinale) contributes gingerols and shogaols, which may reduce perceived salt intensity, potentially enabling sodium reduction without compromising taste (Prabhakar et al., 2025). Dates (Phoenix dactylifera) offer natural sweetness from fructose and glucose, serving as an alternative to refined sugar (Al-Farsi & Lee, 2008). Kuli kuli, the residual press cake from groundnut oil extraction, contains approximately 45–50% protein and imparts umami characteristics through Maillard reaction products (Hamid et al., 2020).

Previous Studies on Suya Spice Production

Research on suya spice formulation remains limited. Existing studies have focused on:

Quality assessment of commercial products: Adeleke and Odedeji (2020) established the gap between traditional and commercial formulations but did not attempt to develop alternatives.

Ingredient characterization: Studies by Falodun et al. (2019), Cortés-Rojas et al. (2014), and Ogunwande et al. (2018) documented chemical properties of individual spices, yet few examined synergistic effects in seasoning blends.
Sensory evaluation: Kusio et al. (2022) examined European-style seasonings, while Odinye and Ejeabukwa (2026) studied vegetable-based powders. Neither addressed indigenous suya formulations.
Consumer preferences: Olusegun and Adebayo (2021) identified taste, aroma, and heat intensity as key acceptability determinants but did not investigate formulation optimization.
Suya processing studies: Aka-Tanimo et al. (2024) investigated the effect of mint leaf-based spice on product yield and physicochemical properties of suya, finding that 10% mint inclusion produced the highest product yield (87.55%). Similarly, Ayo (1999) examined heat processing effects on tsire-suya quality. However, neither study focused on optimizing the spice blend formulation itself.
Spice blend optimization: Research on mixed spices for Nigerian dishes has explored combinations of scent leaf, curry, and African black pepper, finding that a 80:10:10 ratio scored highest for flavour (8.0) and general acceptability (8.0) on a 9-point scale. However, suya-specific formulations remain unexplored.
Notably, no study has systematically optimized a homemade suya spice formulation using indigenous ingredients (uda, cloves, calabash nutmeg, pepper, dates, ginger, and kuli kuli) or developed instructional resources for teaching suya production in hospitality education contexts.

Instructional Materials and Hospitality Education in Nigeria

Hospitality education in Nigerian Colleges of Education follows National Board for Technical Education (NBTE, 2019) minimum standards, emphasizing practical culinary skills, menu planning, and food safety. However, curricula lack modules focused on indigenous spice production or local ingredient processing (Okeke & Nwankwo, 2018).

The value of structured instructional materials in skills acquisition is well established. Borg and Gall (1983) demonstrated that well-designed manuals facilitate procedural learning through step-by-step guidance and visual illustrations. Black and Wiliam (2009) showed that materials incorporating assessment questions and practical activities improve learning outcomes.

Within Nigerian vocational education, Ogunleye and Adebayo (2019) found that students using structured manuals for bread making demonstrated superior practical skill acquisition compared to those receiving conventional instruction. Similarly, Eze and Ugwu (2021) reported improved achievement in poultry processing among students taught with competency-based manuals. However, comparable studies for indigenous spice production in Nigerian hospitality education do not exist, representing a significant gap in the literature.

The literature review reveals several gaps. First, no empirically validated homemade suya formulation exists using indigenous ingredients without synthetic additives. Second, no structured instructional resource is available for teaching suya production in hospitality programmes. Third, previous research has not linked formulation optimization to pedagogical resource development.

Study Objectives

This study addressed these gaps through two objectives:

1. Develop and sensorially evaluate homemade suya spice formulations from indigenous ingredients (uda, cloves, calabash nutmeg, pepper, dates, ginger, and kuli kuli).
2. Compare the sensory acceptability of three homemade formulations and a commercial reference sample.
3. Identify the most acceptable homemade suya spice formulation.

4. Develop an instructional manual for teaching homemade suya spice production.
5. Evaluate the instructional manual using hospitality education expert ratings.

Research Questions

This study was guided by the following research questions:

1. What are the sensory characteristics (appearance, aroma, taste, heat/pungency, and overall acceptability) of homemade suya spice formulations prepared from uda, cloves, calabash nutmeg, pepper, dates, ginger, and kuli kuli?
2. Is there a significant difference in overall acceptability among the three homemade suya formulations (F1: equal proportions; F2: enhanced pepper and ginger; F3: enhanced uda and calabash nutmeg) and a commercial reference sample?
3. Which formulation demonstrates the highest overall sensory acceptability among the three homemade suya spice formulations?
4. How do hospitality education experts evaluate the instructional manual for teaching homemade suya spice production in terms of content accuracy, clarity of instructions, relevance to hospitality education, ease of implementation, and usefulness for culinary competence development?
5. What is the overall suitability of the developed instructional manual for integration into hospitality education curricula in Nigeria?

Materials and Methods

Raw Material Collection

Uda fruits (Xylopia aethiopica), cloves (Syzygium aromaticum), calabash nutmeg seeds (Monodora myristica), dried bird pepper (Capsicum frutescens), dried dates (Phoenix dactylifera, Deglet Noor variety), dried ginger rhizomes (Zingiber officinale), and kuli kuli (peanut press cake) were procured from Ochanja Central Market, Onitsha, Anambra State, Nigeria. All materials were inspected for insect damage, mould, and extraneous matter. Commercial suya spice was purchased from a retail outlet as a reference comparator.

Sample Preparation

Each ingredient was cleaned manually. Uda seeds were separated from pods. Calabash nutmeg seeds were cracked and kernels extracted. Ginger was sliced into 2 mm thickness. Dates were pitted and sliced. Kuli kuli was broken into 1–2 cm fragments. All ingredients were separately dried in a hot-air oven (Model DO-230F, LabTech, Korea) at 50±2°C for 6–10 hours until constant weight (final moisture <6%). Dried materials were milled using a laboratory hammer mill (Model 3100, Perten Instruments, Sweden) operating at 15,000 rpm, passed through a 250 µm sieve, and stored in airtight glass containers at ambient temperature (25±2°C) for no more than 48 hours before blending.

Formulation Design

Three formulations were prepared based on preliminary trials:

F1 (Equal proportion): uda 14.3%, cloves 14.3%, calabash nutmeg 14.3%, pepper 14.3%, dates 14.3%, ginger 14.3%, kuli kuli 14.3% (w/w)

F2 (Enhanced heat and pungency): uda 10%, cloves 10%, calabash nutmeg 10%, pepper 25%, dates 15%, ginger 20%, kuli kuli 10% (w/w)

F3 (Enhanced aromatic spices): uda 20%, cloves 15%, calabash nutmeg 20%, pepper 15%, dates 10%, ginger 10%, kuli kuli 10% (w/w)

Blending was performed in a V-blender (Model S-400, Patterson-Kelley, USA) at 25 rpm for 15 minutes. Formulations were stored in laminated foil pouches at ambient temperature and evaluated within 72 hours of production.

Sensory Evaluation

Thirty semi-trained panelists (undergraduate students of Food Science, age range 19–45 years, 53% female, 47% male) were recruited from Federal Polytechnic Oko, based on familiarity with suya spice, absence of known food allergies, and willingness to participate. Panelists attended two 1-hour training sessions using reference samples for taste attributes (sweet: date powder; salty: 0.5% NaCl; bitter: 0.05% caffeine; umami: 0.5% MSG; pungent: 0.1% capsaicin) and aroma attributes (uda, clove, nutmeg, ginger, roasted peanut).

Suya spice samples (2 g each) were dissolved in 50 mL warm distilled water (60°C) to standardize intensity, presented in 70 mL translucent odourless plastic cups coded with three-digit random numbers. Unsalted crackers and ambient temperature drinking water were provided for palate cleansing. Panelists evaluated appearance (colour uniformity), aroma (intensity and character), taste (overall flavour), heat/pungency (perceived capsaicin burn), and overall acceptability using a 9-point hedonic scale (1 = dislike extremely to 9 = like extremely). Commercial suya spice reconstituted identically served as a reference. Evaluation was conducted in individual sensory booths under white light (ISO 8589:2007 compliance) across two replicated sessions, with sample presentation order randomized.

Development of Instructional Manual

Based on the sensory-optimized F2 formulation, an instructional manual titled "Instructional Manual for Homemade Suya Spice Production" was developed following the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The manual was structured into six modules:

Module 1: Introduction to Suya Spice and Indigenous Ingredients
Module 2: Cleaning and Pre-processing of Raw Materials
Module 3: Drying and Milling Techniques
Module 4: Blending and Formulation (F2 optimized ratio)
Module 5: Quality Control, Packaging, and Storage
Module 6: Application of Homemade Suya Spice in Hotel Culinary Settings

Each module contained learning objectives, step-by-step procedural instructions with illustrations, safety guidelines, assessment questions, and practical activities designed to develop culinary competence. The explicit goal of the manual was to improve culinary competence in hospitality education in Nigeria by providing educators with a ready-to-use resource for teaching indigenous spice production.

Evaluation of Instructional Manual

Five experts in Hospitality education and Food science from Federal College of Education (Technical) Umunze and Federal Polytechnic, Oko evaluated the instructional manual using a 4-point rating scale (1 = Poor, 2 = Fair, 3 = Good, 4 = Excellent) across five criteria: content accuracy, clarity of instructions, relevance to hospitality education, ease of implementation, and alignment with the objective to improve culinary competence in hospitality education in Nigeria. Mean scores and percentages were computed.

Statistical Analysis

Sensory scores were analysed using one-way analysis of variance (ANOVA) with Tukey's Honestly Significant Difference (HSD) post-hoc test ($\alpha = 0.05$) using SPSS version 26.0 (IBM Corp., USA). This analysis addressed Research Questions 2 and 3 by comparing mean scores among formulations. Manual evaluation data were analysed using descriptive statistics (mean, standard deviation, percentage) to address Research Questions 4 and 5.

Results

Sensory Evaluation

Sensory Evaluation (Addressing Research Questions 1, 2, and 3)

Mean sensory scores for the three formulations and commercial reference are presented in Table 1. Formulation F2 achieved the highest scores across all attributes, with overall acceptability of 8.2±0.3 on the 9-point hedonic scale, corresponding to "like very much." F2 significantly outperformed F1 (6.8±0.4, $p<0.001$), F3 (7.1±0.3, $p<0.01$), and the commercial reference (7.5±0.4, $p<0.05$).

Table 1: Sensory Scores of Homemade Suya Spice Formulations and Commercial Reference

Formulation	Appearance	Aroma	Taste	Heat/Pungency	Overall Acceptability
F1 (Equal)	6.5±0.5b	6.7±0.4c	6.9±0.5c	6.4±0.6c	6.8±0.4c
F2 (Enhanced pepper/ginger)	7.9±0.4a	8.1±0.4a	8.4±0.3a	8.3±0.4a	8.2±0.3a
F3 (Enhanced uda/nutmeg)	7.2±0.5ab	7.5±0.5b	7.0±0.5c	6.9±0.5b	7.1±0.3bc
Commercial reference	7.8±0.4a	7.3±0.5b	7.6±0.5b	7.8±0.4ab	7.5±0.4b

Source: Field Survey (2026)

Values are mean ± SD (n=30). Means within a column bearing different superscripts differ significantly (Tukey's HSD, $p<0.05$).

Addressing Research Question 1: The sensory characteristics of the three formulations varied significantly. F2 demonstrated superior attributes across all parameters, with taste (8.4±0.3) and aroma (8.1±0.4) scoring highest, corresponding to "like very much." F1 exhibited moderate scores (6.4–6.9), while F3 showed intermediate scores with higher appearance (7.2±0.5) but lower taste (7.0±0.5).

Addressing Research Question 2: ANOVA revealed significant differences among formulations for all sensory attributes ($p<0.05$). F2 significantly outperformed F1 ($p<0.001$) and F3 ($p<0.01$) in overall acceptability, and also exceeded the commercial reference ($p<0.05$). No significant difference was found between F3 and the commercial reference ($p>0.05$).

Addressing Research Question 3: F2 demonstrated the highest overall sensory acceptability (8.2±0.3), significantly exceeding both F1 (6.8±0.4) and F3 (7.1±0.3). Therefore, F2 was identified as the most acceptable formulation. Taste scores showed the widest variation among formulations. F2 (8.4±0.3) significantly outperformed F3 (7.0±0.5, $p<0.001$) and F1 (6.9±0.5, $p<0.001$). The elevated dates proportion (15%) in F2 provided natural sweetness that balanced pepper pungency and the bitterness of uda and calabash nutmeg. Kuli kuli contributed umami characteristics through free amino acids formed during peanut roasting (Hamid et al., 2020). Aroma scores followed a similar pattern, with F2 (8.1±0.4) scoring higher than F1 (6.7±0.4, $p<0.001$) and commercial reference (7.3±0.5, $p<0.05$). The characteristic aroma profile of F2 derived from volatile compounds including eugenol from cloves, α-pinene and β-pinene from uda, myristicin from calabash nutmeg, and gingerol-derived aldehydes from ginger (Cortés-Rojas et al., 2014; Ogunwande et al., 2018).

Evaluation of Instructional Manual (Addressing Research Questions 4 and 5)

The evaluation results from five hospitality education experts are presented in Table 2. The overall mean score was 3.68±0.21 (87.6% approval), indicating the manual was rated between "Good" and "Excellent" across all criteria.

Table 2: Expert Evaluation of the Instructional Manual

Evaluation Criterion	Mean Score (4-point scale)	Standard Deviation	Percentage Approval
Content accuracy	3.80	0.20	95.0%
Clarity of instructions	3.60	0.24	90.0%
Relevance to hospitality education	3.75	0.22	93.8%
Ease of implementation	3.55	0.28	88.8%

Addressing Research Question 4: Hospitality education experts rated the manual across five criteria. Content accuracy received the highest rating (3.80±0.20, 95.0%), reflecting that the F2 formulation and procedural steps were grounded in the sensory evaluation results and established food processing principles. Relevance to hospitality education (3.75±0.22, 93.8%) and usefulness for culinary competence development (3.70±0.18, 92.5%) were also highly rated. Clarity of instructions (3.60±0.24, 90.0%) and ease of implementation (3.55±0.28, 88.8%) received slightly lower but still positive ratings.

Addressing Research Question 5: The overall mean score of 3.68±0.21 (87.6% approval) indicates high suitability for integration into hospitality education curricula in Nigeria. All criteria exceeded the 3.5 threshold (87.5% approval), confirming that the manual meets professional standards for educational materials.

Discussion

The superior performance of F2 validates the formulation principle of enhancing heat-contributing (pepper) and sweetening (dates) ingredients while maintaining moderate levels of aromatic spices. This finding aligns with optimization studies on seasoning blends, wherein peppers and sweetening agents constituted critical formulation variables (Odinye & Ejeabukwa, 2026).

The dates in F2 provided natural sweetness at 15% concentration. Al-Farsi and Lee (2008) reported that date sugar composition primarily fructose and glucose exhibits greater sweetness intensity than sucrose on a weight basis. This enabled effective sweetening without refined sugar. Additionally, dates offer nutritional advantages including potassium, magnesium, and dietary fibre.

Kuli kuli contributed umami characteristics through free glutamic acid (2.8–3.2 g/100g) formed during peanut roasting (Hamid et al., 2020). This umami contribution enabled sodium reduction through sensory synergy between glutamate and sodium ions (Prabhakar et al., 2025), potentially offering a healthier alternative to MSG-dependent formulations.

The aroma profile of F2 demonstrated that balanced proportions of multiple volatile compounds eugenol from cloves, α-pinene and β-pinene from uda, myristicin from calabash nutmeg, and gingerol-derived aldehydes created a complex, acceptable sensory experience. This balanced approach contrasts with F3, where excessive uda and calabash nutmeg proportions (20% each) resulted in overwhelming aromatic notes that reduced overall acceptability.

The sensory scores obtained in this study are comparable to those reported in related research on spice optimization for Nigerian dishes, where an 80:10:10 ratio of scent leaf, curry, and African black pepper scored 8.0 for flavour and general acceptability. The F2 formulation's 8.2 overall acceptability indicates similar or superior consumer acceptance potential.

Educational Implications

The instructional manual evaluation indicates that hospitality education experts viewed it as suitable for curriculum integration. The manual addresses a documented gap in hospitality curricula, which lack modules on indigenous spice production. Although the NBTE curriculum includes general objectives related to food commodities and seasonings, specific modules on traditional seasoning formulation are absent .

The manual's six-module structure follows established instructional design principles. The ADDIE model used for development has been validated in food-related vocational education contexts, including meat processing technology modules (Handayani et al., 2021) and food processing courses . The expert validation scores (87.6% overall) are consistent with or exceed those reported in similar module development studies, which typically report validation scores of 85-95% for well-developed instructional materials .

By following the six-module structure, students would develop competencies in ingredient identification, traditional processing techniques, and quality control skills transferable to hotel kitchen operations. The manual also introduces "clean label" product development concepts, aligning with contemporary industry trends toward natural and minimally processed foods (Kusio et al., 2022).

The relevance to hospitality education (93.8% approval) suggests that the manual aligns with NBTE curriculum objectives, including: "Identify fresh food commodities and corresponding convenience Nigerian food products in locality" and "Develop lesson plans that focus on flavor balancing and harmonization" .

Comparison with Existing Suya Research

Previous suya research has primarily focused on processing effects and quality parameters. Aka-Tanimo et al. (2024) found that mint leaf inclusion at 10% produced the highest product yield (87.55%) and affected water holding capacity and oxidative rancidity. Similarly, Ayo (1999) examined heat processing effects on tsire-suya quality. However, neither study focused on optimizing the spice blend formulation itself. This study extends the existing literature by systematically optimizing the spice formulation using sensory evaluation, addressing a gap identified in previous studies. The findings suggest that formulation ratios significantly affect consumer acceptability, with balanced heat and sweetness being critical for overall preference.

Limitations and Future Research

This study has several limitations. The sensory evaluation used aqueous solutions rather than grilled meat, which may not fully reflect consumption conditions. Panelists were semi-trained rather than consumers, potentially limiting external validity. The commercial reference sample represented a single brand, and formulations were evaluated within 72 hours, not accounting for storage effects.

The instructional manual evaluation was limited to expert validation without field testing with hospitality students. While expert validation is an established practice in module development research , future research should include field testing to assess actual learning outcomes and skills acquisition. Handayani et al. (2021) demonstrated that module effectiveness can be evaluated through pre/post-test designs, an approach that would strengthen the educational component of this research.

Future research should evaluate formulations in actual grilled meat applications, conduct consumer acceptability testing with larger panels, and assess shelf stability over extended periods. Additionally, field testing of the instructional manual with hospitality students is needed to

determine actual learning outcomes and skills acquisition, following established protocols for educational module validation.

Summary of Findings

This study addressed five research questions. Regarding Research Question 1, the sensory characteristics of the three formulations varied significantly, with F2 demonstrating superior attributes across all parameters. Addressing Research Questions 2 and 3, F2 (25% pepper, 20% ginger, 15% dates, and 10% each of uda, cloves, calabash nutmeg, and kuli kuli) achieved the highest overall acceptability (8.2±0.3), significantly outperforming F1 (6.8±0.4), F3 (7.1±0.3), and the commercial reference (7.5±0.4) ($p<0.05$). Regarding Research Question 4, hospitality education experts rated the instructional manual as "Good" to "Excellent" across all five evaluation criteria, with mean scores ranging from 3.55±0.28 (ease of implementation) to 3.80±0.20 (content accuracy). Addressing Research Question 5, the manual achieved an overall mean score of 3.68±0.21 (87.6% approval), indicating high suitability for integration into hospitality education curricula in Nigeria.

Conclusion

This study successfully developed an optimized homemade suya spice formulation (F2: pepper 25%, ginger 20%, dates 15%, and 10% each of uda, cloves, calabash nutmeg, and kuli kuli) that achieved high sensory acceptability (8.2/9), significantly outperforming alternative formulations and a commercial reference. An instructional manual based on F2 was developed using the ADDIE model and received strong expert approval (87.6%), indicating its suitability for hospitality curricula in Nigeria.

Recommendations

Based on the findings, the following recommendations are made:

1. Hospitality educators should integrate the developed instructional manual into practical culinary courses, particularly in modules covering local dishes and seasoning applications.
2. Hospitality students should be trained in indigenous spice production techniques using the optimized F2 formulation to develop practical skills applicable in hotel kitchen operations.
3. The National Board for Technical Education (NBTE) should consider incorporating modules on indigenous spice production into the national curriculum for Catering Craft Practice and Hospitality programmes .
4. Future research should conduct field testing of the instructional manual with hospitality students, using pre/post-test designs to evaluate learning outcomes and skills acquisition.
5. Further research should evaluate the F2 formulation in actual grilled meat applications and assess consumer acceptability with larger, diverse panel populations.

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