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Simulation of Betel Leaf Extraction as a Provision of Entrepreneurship Knowledge for Students Regarding the Preparation of Raw Materials for Pharmaceutical Products

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Abstract: Referring to the need to provide materials and skills regarding the preparation and extraction of natural ingredients with medicinal potential to vocational pharmacy students, it is necessary to carry out integrated school Community Service (*Pengabdian Kepada Masyrakat* or *PKM*) activities. This Community Service aims to assess the level of knowledge and skills regarding the preparation and extraction of betel leaf simplicia before being formulated into various pharmaceutical products. This Community Service activity was carried out using the method of simulation and demonstration on the preparation and extraction of green betel leaf simplicia. The results of the activities were then evaluated using the pre and post-test methods to measure participants' understanding of the preparation and extraction of betel leaves. The participants of this Community Service were from Daya Utama Vocational High School, consisting of 26 students accompanied by three supervising teachers. Before being given materials and skills for preparing and extracting natural ingredients, the average score of students' knowledge level was 52.5. After the provision of materials and skills, it increased to 69.3. The conclusion was that the student's knowledge level increased by 16.73, with the t-test results showing a significant difference before and after the provision of materials and skills.
Keyword: betel; community service; devotion; extraction; public; simplicia

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INTRODUCTION

Based on the Decision of the Director General of Primary and Secondary Education Number 130/D/KEP/KR/201 dated February 10, 2017, the curriculum structure of the vocational high school (*Sekolah Menengah Kejuruan or SMK*) Pharmacy education emphasizes competencies in clinical and community pharmacy. These competencies focus on preparing vocational high school pharmacy graduates for work in healthcare services such as pharmacies, hospitals, community health centres, and

medication services within the community. However, interviews with vocational high school pharmacy teachers revealed that many vocational high school pharmacy students are interested in creating pharmaceutical products like soap and hand sanitizer from natural ingredients. Their desire is often hindered by a lack of knowledge regarding preparing, identifying, and extracting natural ingredients with potential as phytopharmaceuticals (medicines).

The vocational high school pharmacy curriculum, which primarily emphasizes clinical pharmacy, results in students needing more basic knowledge in selecting, preparing, and extracting natural ingredients from plants. The interest in creating pharmaceutical products from natural ingredients is driven by the motivation to become entrepreneurs by selling natural pharmaceutical products produced by Vocational High School students (Astuti & Taswin, 2020).

Based on the information obtained from interviews with vocational high school teachers, Mitra Keluarga College of Health Sciences is encouraged to conduct integrated community service activities for Vocational High School Pharmacy students. The form of Community Service that we intend to implement is the preparation of samples and extraction of natural ingredients.

The preparation of natural ingredient samples to be presented in this community service activity refers to the training module on simplistic preparation from Parfati and Windono (2016), which includes identification, wet sorting, drying, dry sorting, and pulverization. As for the extraction method, it refers to several previous studies conducted by Puspita et al. (2019) and Puspitasari and Proyogo (2017), which use methods such as maceration, reflux, and soxhlet extraction to extract natural ingredients from plants.

The potential medicinal plant chosen as an example for simulating the preparation and extraction of natural ingredients is green betel leaf (Piper betle). The selection of green betel leaf for the simulation material is based on scientific research conducted at Mitra Keluarga College of Health Sciences, which has demonstrated its ability to inhibit the growth of Propionibacterium acnes bacteria, the cause of acne. Additionally, it references previous research journals by Mufrod et al. (2016), Kusuma et al. (2017), and Manarisip et al. (2020), which have shown that ethanol extracts of betel leaves can inhibit pathogenic bacteria such as *Escherichia coli*, *Staphylococcus aureus, Staphylococcus epidermidis*, *Salmonella t*ype, and *Pseudomonas aeruginosa.* Furthermore, betel leaf's efficacy has been utilized in formulas for making soap, skin antiseptic gels, mouthwash, and its traditional use as a gargle remedy (Sayekti et al., 2022) ; (Haryanti et al., 2020)

Based on the results of the community service activities and previous research, Mitra Keluarga College of Health Sciences, East Bekasi, is interested in conducting integrated community service activities for vocational high school students in Bekasi City. This community service aims to introduce betel leaves as a local plant in Bekasi City with potential antibacterial properties, to be formulated into various pharmaceutical products that have market value for vocational high school pharmacy students in Bekasi City. The results of this community service activity are expected to provide information on the technology of preparing and extracting betel leaf samples before developing them into entrepreneurial products for vocational high school pharmacy students.

METHOD

The community service activity was

conducted at Mitra Keluarga College of Health Sciences, East Bekasi, on December 5, 2022. The planned workflow included planning, implementation, and evaluation. The implementation involved delivering materials using simulation and demonstration methods, which were evaluated through pre-and post-tests.

The planning phase involved initiating offers to participate in community service activities to pharmacy vocational high schools that had established cooperation or a Memorandum of Understanding (MoU) with Mitra Keluarga College of Health Sciences. Several potential vocational high schools were followed up by contacting the pharmacy vocational schools to offer an integrated community service program. This phase also included preparing the formation of several committees consisting of speakers, including two lecturers, Mr. Reza Anindita, M.Sc., and Ms. Apt. Dede Dwi Nathalia, M.Pharm., one laboratory assistant responsible for preparing equipment as well as materials, assisted by eight selected students skilled in phytochemistry. In this phase, plans were made to create a flyer for the Community Service activity to raise awareness about the preparation and extraction of natural ingredients.

The second stage was the implementation phase, conducted by gathering participants in the Auditorium of Mitra Keluarga College of Health Sciences to listen to speakers' opening speeches and introduce the facilities available at the college. Participants then took a 10-minute pre-test. Subsequently, they listened to lectures on the basics of phytochemistry. They engaged in practical exercises on preparing and extracting betel leaves directly in the phytochemistry laboratory of Mitra Keluarga College of Health Sciences. The topics covered included preparing natural ingredients such as wet sorting, dry sorting, drying, pulverization, extraction, and evaporation.

The third stage was the evaluation phase, which involved administering a post-test and conducting several interviews with teachers and participants of the community service activity. The results of the pre-test and post-test, along with the interviews, were then analyzed descriptively to gather information about the success of the community service activity in providing information on the preparation and extraction of betel leaves to the participants.

RESULTS

The community service activities at Mitra Keluarga College of Health Sciences were conducted based on a request from the pharmacy vocational High School in Bekasi. The participating vocational high school was Daya Utama Vocational High School, with the number of participants detailed in Table 1.

Table 1 Participants data of Daya Utama Vocational High School Pharmacy Department, grade XII

Gender	Amount	Percentage
Male	4	15.38 %
Female	22	84.61%
Total	26	100%

Table 1 shows that the 26 participants of the Community Service from the Pharmacy Department of Daya Utama Vocational High School in Bekasi consisted of 4 males (15.38%) and 22 females (84.61%). The socialization of the community service was conducted using flyers sent through the participants' WhatsApp group. The flyer used in this activity can be seen in Figure 1.

Figure 1 Flyer for the socialization of the community service activity

This community service activity was conducted in the classroom and laboratory of Mitra Keluarga College of Health Sciences. The classroom was used to deliver theoretical knowledge, while the laboratory was used to practice the procedures of preparation and extraction of natural material samples. The results of the community service activities in the classroom and laboratory are shown in Figure 2.

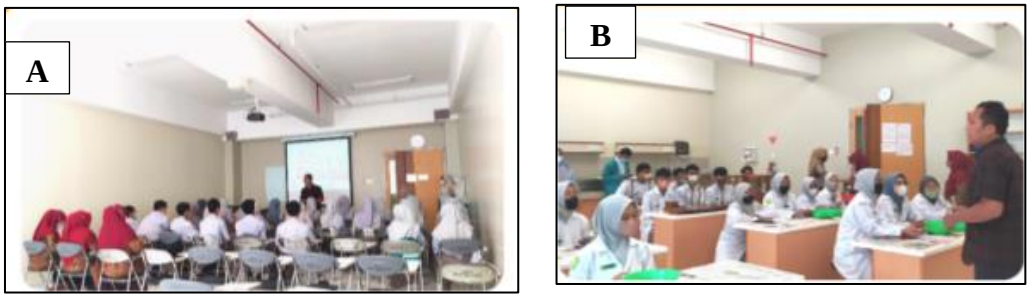

Figure 2 Community service activities in the classroom (A) and laboratory (B)

Figure 2 shows the activities of the community service in the classroom. They began with a pre-test followed by the delivery of material on the stages of preparing natural materials with medicinal potential, extraction, and solvents for extraction. Table 2 shows the key points of the material presented in this community service.

Table 2 Points of the community service material on preparation and extraction of natural materials

Material	Sub material
Preparation of natural material samples	Identification of plant parts, wet sorting, cutting, drying, and dry sorting pollination
Extraction	Extraction definition, types of extraction, maceration, soxhlet extraction, reflux, and distillation
Evaporation	Rotary evaporator and water bath

The community service material in Table 2 was presented for 60 minutes, followed by practical exercises in the laboratory. The natural material sample used in this community service was green betel leaf (Piper beetle). Figure 3

documents the practical activities of preparing and extracting betel leaves.

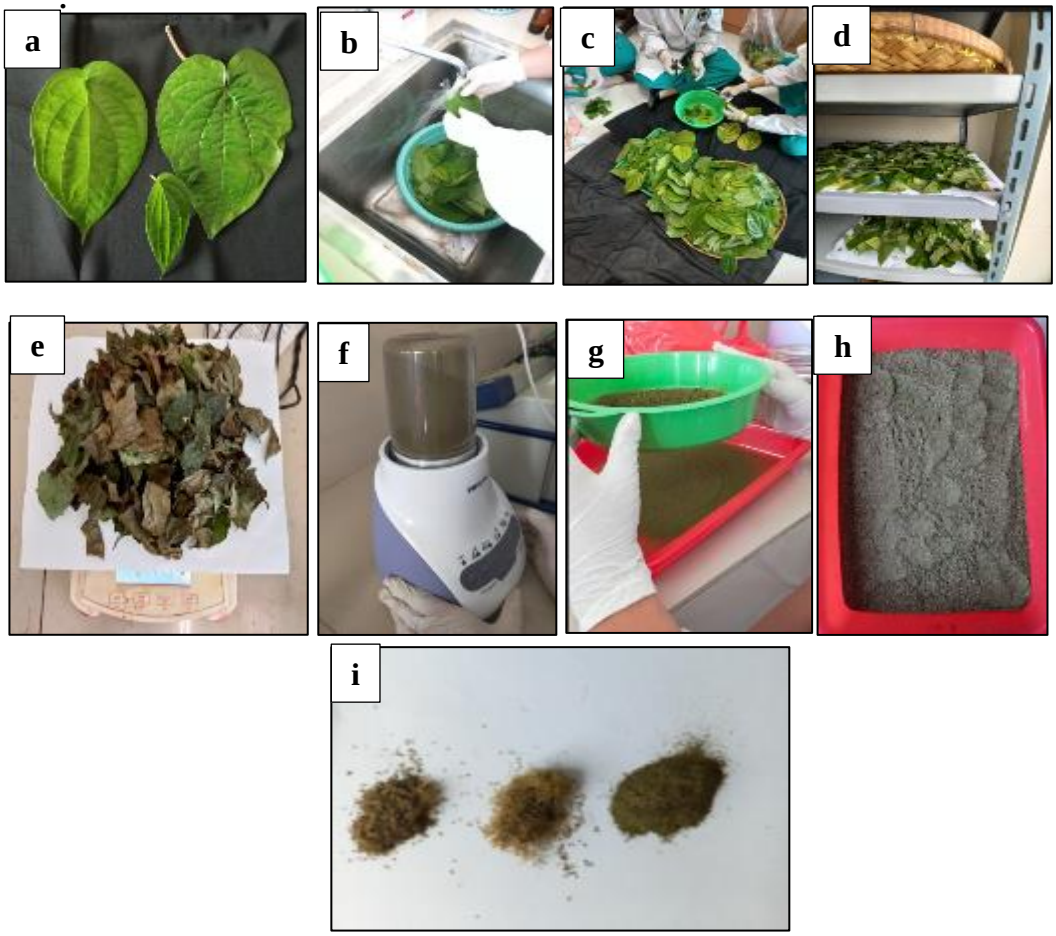

Figure 3 Procedure for preparing green betel leaf simplicia, (a) Identify the morphology of the betel leaf, (b) Wet sorting, (c) Cutting, (d) Drying, (e) Dry sorting, (f) Pollination, (g) Sieving, (h) Fine powder of betel leaf, and (i) Texture of the powder obtained from sieving

The fine powder of green betel leaf shown in Figure 3 was then extracted using maceration, Soxhlet extraction, reflux, and distillation. The extraction activities were depicted in Figure 4 and 5.

Figure 4 Maceration procedure (a) Weigh the powdered betel leaf, (b) Mix the powder with ethanol in a bottle and let it stand for three days, (c) Perform maceration, and (d) Result of maceration (macerate)

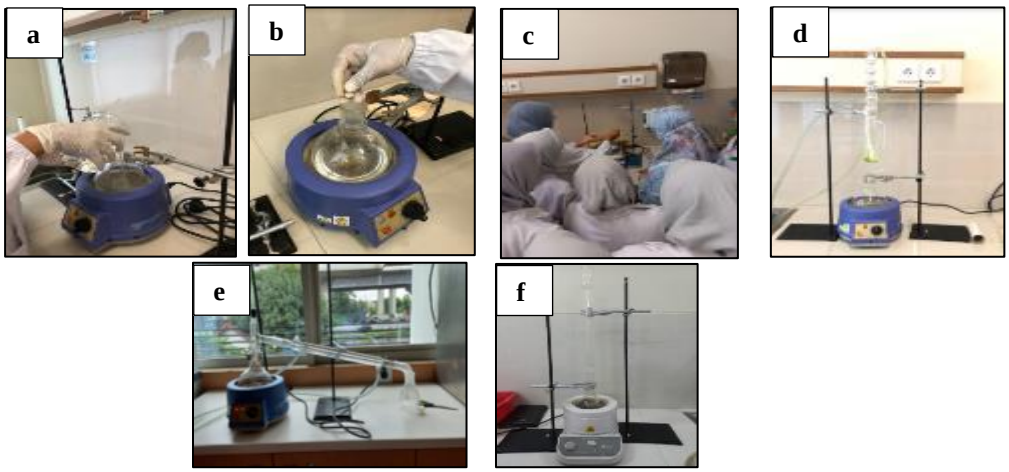

Figure 5 Procedure for hot extraction, (a) Add ethanol solvent, (b) Insert boiling stones, (c) Assemble the extraction apparatus, (d) Soxhlet extraction setup, (e) Reflux setup, and (f) Distillation setup

The extract from the extraction methods was then subjected to evaporation using a rotary evaporator. Figure 6 explains the rotary evaporator setup.

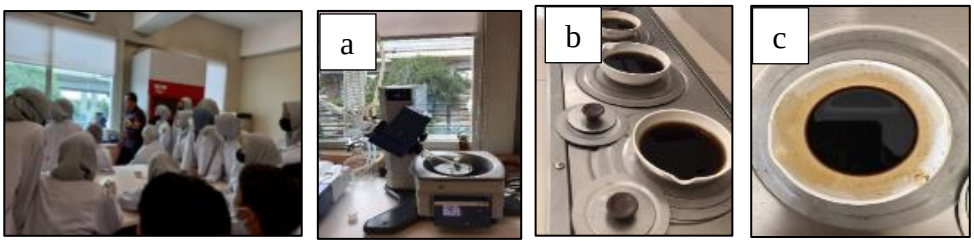

Figure 5 The concentrated extract obtained using a rotary evaporator (a) Rotary evaporator setup, (b) Evaporation of liquid extract with a water bath, and (c) Concentrated extract

Figure 6 showsshows the final stage of extraction, solvent evaporation conducted using a rotary evaporator to produce a concentrated extract without ethanol solvent. Participants who had attended the community service activity from beginning to end were then evaluated by taking a post-test using multiple-choice questions. The post-test results were then compared with the pre-test shown in Figure 7.

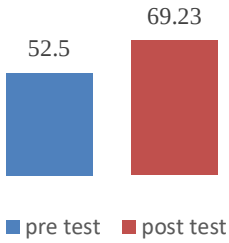

Figure 7 The average scores of the pre-test and post-test

Figure 7 depicts the evaluation diagram of the knowledge level of

students from Daya Utama Vocational High School, Grade 12, Pharmacy Department, showing an average pre-test score of 52.5 and a post-test score of 69.23. This indicated an increase of 16.73%. The paired t-test resulted in a p-value of <0.005, indicating a significant effect of delivering the material on the preparation and extraction of natural material samples on the average post-test scores.

This community service activity involved providing lectures and practical sessions on preparing and extracting natural ingredients from plants with medicinal potential. There were 26 students from Daya Utama Vocational High School, Grade XII, Pharmacy Department, accompanied by 3 teachers. The selected plant material used as an example was green betel leaf (Piper beetle). According to Saraswati et al. (2019), green betel leaf belongs to the Piperaceae family and has numerous medicinal properties for treating and preventing diseases caused by pathogenic bacteria. In traditional medicine practices, betel leaves mixed with gambir are often used for chewing, known as ”ginang" or "nyirih," a custom passed down through generations. Chewing betel leaves helps prevent oral problems such as canker sores and bad breath. Azzahra et al. (2018) stated that betel leaves contain approximately 4.2% essential oils. Jamil et al. (2021) noted that the essential oil in betel leaves is eugenol, known for its antibacterial and antiseptic properties.

Several previous studies referenced in presenting the scientific evidence of green betel leaf as an antibacterial include the research by Patil et al. (2015), which demonstrated that the administration of 5% and 10% ethanol extracts of betel leaves could inhibit the growth of *S. aureus* and *S. thypii* bacteria with inhibition zone diameters ranging from 12.6 to 10 mm. The material on the systematic preparation and extraction of betel leaf samples to obtain ethanol extracts refers to the research methods of Yasi et al. (2022), which encompassed identification, wet sorting, cutting, drying, dry sorting, pulverization, extraction, and evaporation.

In this community service activity, the identification of betel leaves was conducted through morphological identification. Determination of the morphological characteristics of betel leaves referred to plant anatomy books authored by Tjitrosoepomo (2020) and Rosanti (2014), which included leaf shape, leaf base, leaf margin, leaf apex, leaf venation, leaf surface, and leaf type. Green betel leaves, for instance, are oval-shaped and have a lobed base, smooth margins, and pointed tips. Both leaves have smooth surfaces and curved venation and are classified as single leaves. Another characteristic of betel leaves is their organoleptic properties, producing a strong aromatic odour with a bitter and spicy taste.

In the presentation of materials, it was agreed to use the term ”simplisia” to refer to parts or organs of plants that have been dried and have not yet been processed into pharmaceutical products (Mukhriani, 2014). The identified simplisia of betel leaves were then subjected to wet sorting under flowing water to remove dirt and soil adhering to the green betel leaf simplisia (Wahyuni et al., 2014). The wet sorting results were then weighed to obtain the wet weight. The next stage involved cutting, which aims to accelerate the drying process.

The cutting process involved cutting green betel leaves into uniform sizes using scissors, and the cut pieces were placed on newspaper (Handoyo & Pranoto, 2020). The cut pieces were then placed on drying racks and covered with black cloth. According to Dharma et al. (2020), the drying method where simplisia is covered with black cloth and dried under sunlight is called ”*dikeringanginkan*." This method aims to

reduce and prevent enzymatic reactions that could potentially cause changes (transformations) in secondary metabolite compounds.

According to Winangsih et al. (2013), the drying process is capable of reducing the moisture content in simplisia. The moisture content must be reduced to ≤ 10% to halt enzymatic reactions that cause secondary metabolite compounds in betel leaves, such as essential oils, to degrade into other forms or evaporate due to high temperatures from direct sunlight exposure. Therefore, the lower the moisture content, the higher the yield of essential oils contained in green betel leaves.

The drying of betel leaves lasted for 7 days, with simplisia considered dry when it produced a crisp sound when squeezed and crumbled into pieces. Afterward, the simplisia was weighed to obtain its dry weight.

Once dried, the simplisia was then ground or pulverized using a blender until fine. The finely ground simplisia, now in powder form, was then sieved using a mesh sieve no. 5 to achieve uniform simplisia powder.

According to Pradana (2016), pulverization aims to increase the surface area of betel leaf simplisia. This is because a larger surface area of simplisia powder allows solvents to come into contact more easily and extract secondary metabolite compounds contained within the betel leaf simplisia. The particle size of the powder should be fine enough; if too coarse, many secondary metabolite compounds within the cells may not be well-extracted, whereas if too fine, cell walls may rupture, leading to unwanted compounds being extracted. Additionally, overly fine powder complicates the extraction process because fine simplisia powder forms a suspension that is difficult to separate during extraction.

The finely powdered simplisia was then extracted using maceration, Soxhlet extraction, reflux, and distillation methods. According to Salamah et al. (2017), extraction is drawing or separating secondary metabolite compounds using appropriate solvents, where polar compounds dissolve in polar solvents and non-polar compounds dissolve in non-polar solvents.

The extraction process consists of two methods: cold extraction (e.g., maceration) and hot extraction (e.g., Soxhlet extraction, reflux, and distillation). In this Community Service activity, extraction was carried out using maceration, Soxhlet extraction, reflux, and distillation.

According to Susanty and Bachmid (2016), maceration involves soaking betel leaf simplisia in a solvent at room temperature to minimize the degradation of secondary metabolite compounds. The principle of maceration is to replace the solvent repeatedly to achieve equilibrium between the solution inside and outside the cells.

As for reflux, Soxhlet extraction, and distillation, these were extraction methods that involved heating adjusted to the boiling point of the solvent used. The reflux and Soxhlet extraction principle involved using a condenser (reflux cooler) and a relatively constant solvent. The difference lay in reflux, where there was direct contact between simplisia powder and the solvent, whereas in Soxhlet extraction, simplisia and the solvent did not have direct contact.

According to Ma'sum and Proborini (2016), the principle of distillation is to separate compounds that evaporate with water as the solvent. This method is used for extracting essential oils.

The extraction result in this community service activity was a liquid extract, which was then evaporated using a rotary evaporator. The principle of this equipment is to evaporate the extraction solvent, leaving behind the extracted compounds known as concentrated

extract. If the sample was not sufficiently concentrated, it was transferred to a dish and evaporated using a water bath (Reo et al., 2017).

The solvent used in this community service activity was 70% ethanol. This use aligns with the findings of Anindita et al. (2022), who stated that ethanol is a universal polar solvent that has been scientifically proven to be a good and optimal solvent for dissolving secondary metabolite compounds present in betel leaves.

In this community service activity, one of the questions asked by participants was about why the maceration method is more commonly used compared to Soxhlet extraction and reflux. Regarding this question, according to Badaring et al. (2020), maceration does not involve heating; thus, it can prevent damage to thermolabile (heat-sensitive) secondary metabolite compounds. In contrast, Soxhlet extraction and reflux involved heating processes, which increased the risk of damaging thermolabile compounds. Therefore, reflux and Soxhlet extraction were only suitable for extracting secondary metabolite compounds that were thermostable or heat-resistant.

Overall, the evaluation results of the knowledge level of Vocational High School Daya Utama students in the 12th-grade pharmacy department showed an average pre-test score of 52.5 and a post-test score of 69.23. These scores increased by 16.73%. The paired t-test results yielded a value of $p < 0.005$, indicating a significant effect of providing training on preparing and extracting natural product samples on the average post-test scores. These findings were consistent with the research of Astuti and Taswin (2020), which demonstrated a significant difference before and after training on simulations in both Indonesian and English for pharmaceutical service personnel.

Based on the results above, the community service from the Undergraduate Pharmacy Study Program of Mitra Keluarga College of Health Sciences has shown positive and beneficial outcomes for its target audience. In addition, this activity had also successfully introduced methods for preparing natural medicinal ingredients to graduates of vocational high school pharmacy programs, hoping to increase participants' interest in entrepreneurial activities related to pharmaceutical products using plant-based raw materials.

CONCLUSION

This activity was part of an integrated school community service program. Participants were 26 students from Daya Utama Bekasi Vocational High School, accompanied by 3 teachers. Their knowledge level before receiving materials on preparing and extracting natural ingredients resulted in an average score of 52.5. However, after receiving the materials and skills for preparing and extracting natural ingredients, their average score increased to 69.23, indicating an improvement of 16.73%.

One limitation of this community service activity was still the focus on providing materials and skills for preparing and extracting natural ingredients. Therefore, it was recommended that future community service activities focus on creating pharmaceutical products from the concentrated extracts that had been produced.

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