The Contribution of Forgotten Foods for Supporting Food Security in Gunungkidul, Yogyakarta – Indonesia

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ABSTRACT

Background: *Gunungkidul*, one of the districts in the special region of Yogyakarta – Indonesia, was reported to have a significant number of food-insecure villages. However, it conserved various forgotten protein-source food as a regional heritage delicacy. This study aims to evaluate the contribution of forgotten foods (edible insects, aquatic animals, indigenous plants) to support food security among poor households in *Gunungkidul* district, Indonesia. **Methods:** Food security status was evaluated according to the method by Maxwell. The characteristics of socio-economic households, food consumption behaviour, nutritional status of children under five, and health status of mothers and children among the targets were also assessed through an interview using a structured coded questionnaire. The food consumption pattern was analyzed by using food recall 2 x 24 hours and a semi food frequency questionnaire. This study involved 240 poor households below the poverty line, mainly farmers (60%). **Results:** This study revealed that 48% of households were food-insecure, 39% were food-vulnerable, 8% were less food-secure, and 5% were food-secure. Aquatic animals and edible insects contributed as many as 22 making up for 1% of daily protein needs, respectively. A preference shifting on those forgotten foods seems to become one barrier to this contribution. **Conclusion:** The forgotten foods might be an alternative to a future challenge in supporting human well-being. In this case, aquatic animals and edible insects are considered as future protein sources.

Keywords: *Biodiversity; Food security; Protein; Malnutrition.*

Introduction

The world faces a challenging situation to achieve zero hunger in the middle of rapid global population growth, environmental degradation, biofuel expansion, pandemic and climate change (Rahimi *et al.*, 2022, Woodward and Porter, 2016). It is predicted that the world could not significantly alleviate the problem of hunger by 2030 (Cooper *et al.*, 2021). The effect could be massive, particularly among the vulnerable and poor population (Rahimi *et al.*, 2022). Many children and poor people had lived in food-insecure conditions before the pandemic who had been reported to grow considerably due to COVID-19 (Mills *et al.*, 2021, Ohri-Vachaspati *et*

al., 2021). Not only hunger but also poverty was estimated to increase, followed by welfare loss in most countries. It has been predicted that an additional 68.2 million people will fall into poverty globally..

Many efforts have been made to overcome those situations, such as inducing sustainable food production, improving the quality of food chain, raising public awareness of food and nutrition security, improving socio-economic status, and so on (Decerf *et al.*, 2021, Raimondi, 2013). Some programs could be implemented, but still they are not able to meet the goal (Fraser *et al.*, 2022). It has been estimated that currently, more than two billion people live with poor access to safe, nutritious, and sufficient food (Elgar *et al.*, 2021). Moreover, the global climate change and mass biofuel production trend made the countries to struggle in produce sufficient food for all people (Painter *et al.*, 2022, Rahimi *et al.*, 2022, Woodward and Porter, 2016). This suggests that global food security is impossible to achieve unless some food alternatives are found (Woodward and Porter, 2016). Some non-commercialized or so-called forgotten foods could be the disruptor which may enable them to meet the future demands with the following characteristics: nutritious, affordable, adaptive, and sustainable. A systematic review revealed that some neglected plants indeed were able to contribute to alleviating some malnutrition problems (Desire *et al.*, 2021).

The increasing population in Indonesia also leads to an escalation of people's needs for food. However, when awareness raises regarding this fact , Indonesia still has triple burden malnutrition left behind. More than half of Indonesians (53.4%) consume protein below the recommendation (Indonesian Ministry of Health, 2014). Even some regions, such as *Gunungkidul*–Yogyakarta reported that almost 60% of the people consume protein amounts less than adequate(Indonesian Ministry of Health, 2014). Nowadays, the high quality protein

is mostly correlated with high price. Therefore, inadequate protein intake has mostly occurred among the poorest population. A locally available quality protein is urgently required to cover people's needs, particularly in food-insecure areas. In the event of a high rate of food- insecure households (Food Security and Extension Agency, 2016), *Gunungkidul* preserves many forgotten foods that might be suitable as a sustainable future protein, like edible insects, aquatic animals, indigenous plants which are adaptive in dry climate conditions (Lampariello *et al.*, 2012, Oyeyinka and Oyeyinka, 2018, Palupi *et al.*, 2020). Not only nutritious, but also some forgotten foods could also be produced more sustainably with less water, land, and energy (Govorushko, 2019, Patel *et al.*, 2019, Premalatha *et al.*, 2011).

The main aim of this research is to identify the portrait of food insecurity status among the poor households in *Gunungkidul*. This area was selected as the best representative for the study site since it has the highest number of food-insecure villages and prominently conserved local food, and represents Indonesia's topography with agrarian– and maritime– profiles. Moreover, this study intends to evaluate the contribution of some forgotten foods in supporting food security among the poor. In the end, this study is expected to give a new picture of diet alternatives for a future challenge in supporting human wellbeing.

Materials and Methods
Study site
This was a cross-sectional study located in Gunung Kidul District, Yogyakarta-Indonesia. Gunungkidul Regency has an area of 1485.36 km^2 which covers 18 sub-districts and 144 villages. Patuk village, Gunungkidul Regency was selected as try-out location to validate the questionnaire. Furthermore, two villages, *i.e.* Pucung and Mertelu, were selected as study sites since both were representatives of high and coastal land areas, respectively (**Figure 1**).
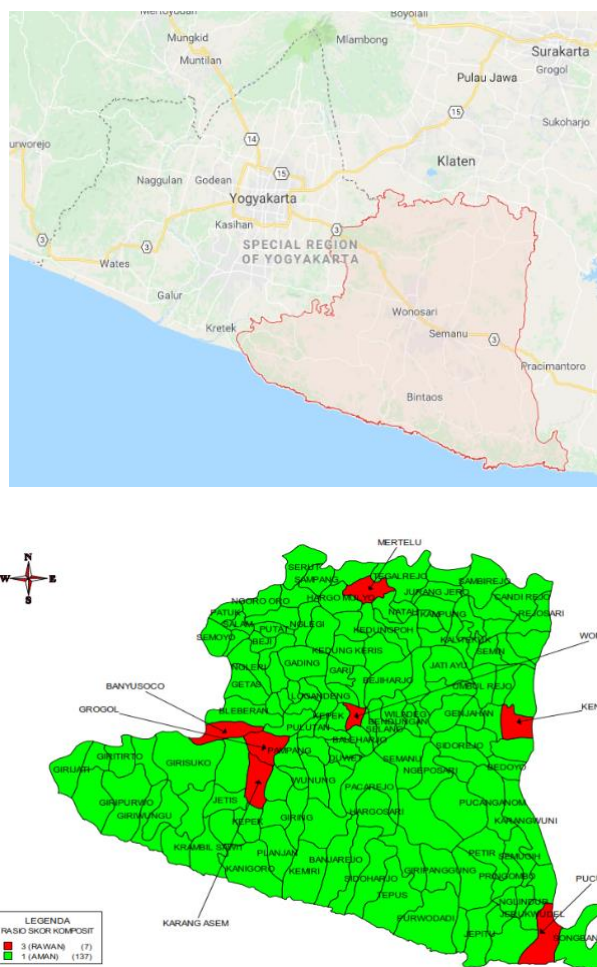
Figure 1. Study location: *Gunungkidul* Regency, Yogyakarta, Indonesia (red area indicates food-insecure status). Source: (Food Security and Extension Agency, 2016).

Population and sampling

The population included households in Pucung and Mertelu villages. Purposive sampling was used with the following inclusion criteria: poor households (PH) with under-five children. The exclusion criteria consisted of the family moving to other regions out of Pucung and Mertelu. PH data will be obtained from the village's office according to data from the subsidized-rice recipients in those villages. Only households with an income of under the minimum wage line can receive this subsidy. Therefore, the households in this study have been selected based on the receiver of rice subsidies and the list of under-five children from Public Medical Centers. From the list, the sample was selected randomly according to the inclusion and exclusion criteria.

Sample size

The sample size was calculated according to the population percentage of people in food-insecure areas. In 2018, Indonesia had a population of food-insecure households which was approximately 16.94% (Peta Ketahanan dan Kerentanan Pangan, 2020). The 95% confidence interval and the absolute precision of 5% were used on this sampling calculation. The calculation was obtained by using the sample population formula (Lwanga and Lemeshow, 1991). In the end, after a 10% addition as the dropout anticipation, as many as 240 households had to participate in this study. 120 respondents from each village Pucung and Mertelu were involved in this survey using a structured coded questionnaire (**Table 1**).

Table 1. Location, and number of respondents for nutritional survey

Location (Dukuh or sub-village)	Number of respondents
Nutritional survey in *Pucung*	
Wotawati	19
Ngreyung	19
Traju	5
Karang Tengah	4
Bengle	4
Pakelkopek	4
Pucung	7
Nujo	23
Wonotoro	25
Kandri	10
Total	**120**
Nutritional survey in *Mertelu*	
Piji	12
Mertelu Kulon	13
Mertelu	11
Mertelu Wetan	6
Gandu	9
Krinjing	10
Baturturu	8
Soka	13
Guyangan Kidul	12
Guyangan Lor	26
Total	**120**

Nutritional survey

A nutritional survey was performed to portray the socio-economic, nutritional, health, and food security status of the selected sites. The questionnaire for the nutritional survey was developed to gather the following information: 1) the socio-economic data of the selected households of each village (education of husband and wife, occupation of husband and wife, household income, expenditure: food and non-food expenditure, and characteristics of the children under five; 2) household food consumption data (recall 2x24 hours, semi-quantitative Food Frequency Questionnaire); 3) nutritional status obtained from anthropometry measurement of under-five children (age and sex of the children, height-for-age, weight-for-age, weight-for-height); and 4) health status of mothers and children.

Ethical cobsiderations

The research was performed based on an ethical clearance from the Ethical Committee from Health Polytechnics Yogyakarta entity with number LB.01.01/KE-01/XLIII/889/2018.

Data analysis

The existing data was coded, entered, and cleaned, and anthropometric measurement results were processed using WHO AntroPlus 1.0.4. The z-score score was categorized to obtain the nutritional status of under-five children. Twentyfours of feeding were assessed using Nutri-survey 2007. Then, data analysis was performed using SPSS 16.0. Moreover, food security status was classified according to Maxwell (Maxwell *et al.*, 2013) which can be grouped into four categories, *i.e.* (1) food-secure, if the proportion of food expenditure is low and energy intake is adequate; (2) food-vulnerable, when the proportion of food expenditure is high but energy intake is adequate; (3) lack of food, when the proportion of food expenditure is low but energy intake is inadequate; and (4) food-insecure, when the proportion of food expenditure is high and energy intake is inadequate.

Results

Socio-economic status

Most of the respondents are within the age category of 26-35 (18%), 36-45 (26%), and 46-55 (23%), this was while the average age of respondents was 47 years. In this age range, respondents were still productive and in working age. However, most of them were living in poverty. It was recorded that most of the beneficiaries in this study were farmers (60%) with the elementary school education and an average capita income of Indonesian rupiah (IDR) 517,187, 99% of whom were below the poverty line (**Table 2**). The average family income in Pucung Village was IDR 1,951,600 higher than Mertelu Village (IDR 1,554,800). Regency minimum wage based on the regency/city minimum wage 2018 DIY KEP No.223/KEP/2017 was IDR 1,454,200. The majority (98%) of the respondents were women. Only 23% were housewives, and the rest were helping their families earn a living (farming, laboring, trading, *etc.*). Jobs in the agricultural sector in Indonesia did not require high education.

Most of the respondent's households in Pucung Village (82%) and Mertelu Village (83%) belonged to medium families, with the average family numbers of 3.95 and 3.77, respectively. Family Planning Program, which had been held since 1970s, brought success in society in the formation of small, happy, and prosperous families, with the slogan "Two Children is Enough", the generation that started married life in 1980s eventually had 2-3 children, while the previous generations had 4-6 children.

Table 2. Socio-economic characteristics of the respondents and their households in the study.

Characteristics	Pucung n=120	Mertelu n=120	Total n=240	P-value
Sex				
Male	2 (2.0)[a]	2 (2.0)	4 (2.0)	1
Female	118 (98.0)	118 (98.0)	236 (98.0)	
Position in the family				
Father	2 (1.7)	2 (1.7)	4 (2.0)	0.04
Mother	105 (87.5)	117 (97.5)	222 (93.0)	
Child	8 (6.7)	0 (0.0)	8 (3.0)	
Brother/sister	1 (0.8)	0 (0.0)	1 (0.4)	
Grandparent	4 (3.3)	1 (0.8)	5 (2.0)	
Household members	3.95±1.55[b]	3.77±1.58	3.86±1.56	0.36
Small (<2 people)	4 (3.0)	4 (3.3)	8 (3.0)	
Medium (2-6 people)	98 (82.0)	100 (83.3)	198 (83.0)	
Big (>6 people)	18 (15.0)	16 (13.4)	34 (14.0)	
Age (y)	45.93±15.66	48.08±14.43	47.00±15.07	0.26
17-25	10 (8.0)	4 (3.3)	14 (5.9)	
26-35	24 (20.0)	20 (16.7)	44 (18.3)	
36-45	27 (23.0)	35 (29.0)	62 (25.8)	
46-55	27 (23.0)	27 (22.5)	54 (22.5)	
56-65	16 (13.0)	15 (12.5)	31 (12.9)	
>65	16 (13).0	19 (16.0)	35 (37.1)	
Education level				
Not completed elementary school	13 (10.8)	24 (20.0)	37 (15.4)	0.03
Elementary school	69 (57.5)	69 (57.5)	138 (57.5)	
Junior high school	30 (25.0)	18 (15.0)	48 (20.0)	
Senior high school	7 (25.0)	7 (5.8)	14 (5.8)	
Bachelor's degree	0 (0.0)	0 (0.0)	0(0.0)	
Unknown	1 (0.8)	2 (1.7)	3 (1.3)	
Occupation[c]				
Does not work	7 (5.8)	0 (0.0)	7 (3.0)	0.36
Farmers	62 (51.8)	82 (68.3)	144 (60.0)	
Trader	1 (.8)	5 (4.2)	6 (3.0)	
Farm workers	7 (5.8)	1 (0.8)	8 (3.0)	
Non-farm workers	9 (7.5)	1 (0.8)	10 (4.0)	
Services (drivers, tailors, brokers etc.)	0 (0.0)	2 (1.7)	2 (1.0)	
Housewife	30 (25.0)	26 (21.7)	56 (23.0)	
Others	4 (3.3)	3 (2.5)	7 (3.0)	
Income per capita	545,980±274,027	488,393±315,960	517,187±296,525	<0.001
Low (< IDR 1,454,200 /month)	119 (99.0)	119 (99.0)	239 (99.0)	
High (≥ IDR 1,454,200 /month)	1 (1.0)	1 (1.0)	2 (1.0)	
Household income (IDR/month)	1,951,600±814,554	1,554,800±716,971	1,753,200±791,095	<0.001
Minimum	143,000	449,000	143,000	
Maximum	4,480,000	4,095,000	4,480,000	

IDR: Indonesian rupiah; [a]: n(%); [b]: Mean±SG; [c]: Several respondents have more than one job, only main occupations were analyzed here, other types of work consist of private employees, *Tempe* makers, craftsmen, tailors, and entrepreneurs; P-value was calculated using independent sample t-test for quantative variables and Chi square for categorical variables for comparing Pucung and Mertelu.

Under-five children

Among the children in this study, 7% were born with low birth weight, and 1% were premature. Nutritional assessment among the toddlers revealed that double-burden malnutrition occurs among the toddlers in the target area. 7% of the participants were underweight (severely underweight and underweight), and at the same time, 7% were overweight (weight-for-age, **Table 3**). In total, 4 and 15% of the toddlers were severely stunted and stunted, respectively. Based on weight-for-height, 1% of the toddlers were severely wasted. On the other hand, 13% of them faced a risk of being overweight, and 1% were obese**.**

Table 3. Nutritional status of under-five children in the villages of Pucung and Mertelu.

Nutritional status	Cut off z-score	Pucung	Mertelu	Total	P-value
According to weight-for-age z-score (WAZ)					
Severely underweight	< -3	0 (0.0)	2 (6.0)	2 (3.0)	
Underweight	-3 - -2	3 (7.9)	0 (0.0)	3 (4.0)	
Normal	-2 - 1	31 (81.6)	30 (91.0)	61 (86.0)	
Possible risk of being overweight	> 1	4 (10.5)	1 (3.0)	5 (7.0)	
Mean z-score ± SD		-0.44±1.01	-1.06±0.89	-0.72±1.00	0.008
According to Height-for-age z-score (HAZ)					
Severely stunted	< -3	1 (3.0)	2 (6.0)	3 (4.2)	
Stunted	-3 - -2	3 (8.0)	8 (24.0)	11 (15.5)	
Normal	-2 - 3	34 (89.0)	23 (70.0)	57 (80.3)	
Tall	> 3	0 (0.0)	0 (0.0)	0 (0.0)	
Mean z-score ± SD		-0.67±1.41	-1.58±0.86	-1.09±1.26	0.002
According to Weight-for-height z-score (WHZ)					
Severely wasted	< -3	0 (0.0)	1 (3.0)	1 (1.0)	
Wasted	-3- -2	0 (0.0)	0 (0.0)	0 (0.0)	
Normal	-2 - 1	34 (89.0)	26 (79.0)	60 (85.0)	
Possible risk of overweight	1 - 2	4 (11.0)	5 (15.0)	9 (13.0)	
Overweight	2 - 3	0 (0.0)	0 (0.0)	0 (0.0)	
Obese	> 3	0 (0.0)	1 (3.0)	1 (1.0)	
Mean z-score ± SD		-0.01±0.92	-0.09±1.36	-0.04±1.14	0.773

P-value was calculated using independent sample t-test comparing Pucung and Mertelu.

Food and nutrition security: Food security in the studied area was examined based on two indicators, *i.e.* food expenditure and energy adequacy. Non-food expenditure in **Table 4** shows that the average non-food expenditure of *Gunungkidul* was IDR 612,275. The highest average non-food expenditure was observed in Pucung Village households (IDR 683,885). The average food expenditure in Pucung and Mertelu villages was IDR 820,580, with a large food expenditure in Pucung compared to Mertelu, which was significantly different.

The mean of consumption in Pucung and Mertelu showed that the household consumption in both villages did not reach the energy level required, which is only 1101 from 2150 kcal/d needs (51%, **Table 4**). Based on energy sufficiency, food security at the household level showed that the majority of households (209; 87%) in *Gunungkidul* were classified as food-insecure because their energy sufficiency level was below the required level (≤80%, **Table 4**). The status of food security between the two villages was not significantly different.

The distribution of households based on the degree of food security shows that most of the households belonged to food-insecure category. 48% of the participants were identified as a food-insecure group (**Table 4**). It was found that 53 households, or 44% of the participants in Pucung and 52% in Mertelu, were in the food-insecure category. Food insecurity means that the proportion of household food expenditure is high, and energy consumption is low. The percentage of food expenditure and the level of energy consumption proved that the level of

household welfare or food security was still low. Food-insecure households did not have enough

income to access food with good quality and nutrition.

Table 4. Food and non-food expenditure, and food security status based on household energy sufficiency.

Food and non-food expenditure	Pucung n=120	Mertelu n=120	Total n=240	P-value
Expense amount (IDR)				
Food expenditure				
Mean±SD	894,412±358,880	746,748±252,365	820,580±318,297	<0.001
Min-Max	92,000-2,088,000	315,500-1,700,000	92,000-2,088,000	
Non-food expenditure				
Mean± SD	683,885±475,570	540,665±394,603	612,275±441,970	0.01
Min-Max	15,000-2,278,000	46,000-1,925,100	15,000-2,278,000	
Total expenditure				
Mean±	1,578,300±702,398	1,287,400±574,321	1,432,900±656,600	0.001
Min-Max	107,000-3,893,000	374,700-3,416,000	107,000-3,893,000	
Proportion of food and non-food expenditure				
Percent of food expenditure				0.32
Mean± SD	60.11±14.63	61.90±13.41	61.0±14.03	
Min-Max	24.84-90.82	29.29-89.98	24.84-90.82	
Percent of non-food expenditure				
Mean± SD	39.89±14.63	38.10±13.41	38.99±14.03	0.32
Min-Max	9.18-75.16	10.02-70.71	9.18-75.16	
The category of food security based on the proportion of food expenditure				
Food insecure (≥60%)	49 (41.0)[a]	60 (50.0)	109 (45.0)	0.32
Food secure (<60%)	71 (59.0)	60 (50.0)	131 (55.0)	
Energy intake (kcal/day)				
Mean± SD	1113±480	1089±460	1101±469	0.70
Min-Max	386-2591	441-2834	386-2834	
Category of food security based on energy sufficiency				
Food insecure (≤80%)	105 (88.0)	104 (87.0)	209 (87.0)	0.84
Food secure (>80%)	14 (12.0)	15 (13.0)	29 (13.0)	
Food security status of the household				
Food secure	5 (4.2)	6 (5)	11 (5.0)	0.84
Food vulnerable	9 (7.5)	9 (7.5)	18 (8.0)	
Lack of food	51 (42.5)	43 (35.8)	94 (39.0)	
Food insecure	53 (44.2)	62 (51.7)	115 (48.0)	

[a]: n (%); **IDR**: Indonesian rupiah; P-value was calculated using independent sample t-test for quantative variables and Chi square for categorical variables for comparing Pucung and Mertelu.

It was also found that 39% of the cases (94 households) were classified as lacking food, which means the proportion of food expenditure was low, but the energy intake was lacking. 18 households (8%) belonged to the food-vulnerable groups, and only 5% had a food-secure status. There was no significant difference between Pucung and Mertelu in terms of food security. The condition of household food shortages might be caused by low economic levels, causing the need for large funding allocations for non-food needs, such as education and transportation, which causes the

proportion of food expenditure to be low but not enough to meet the energy needs of the family members. The low level of energy consumption might be due to the lack of nutrition knowledge of the mother to regulate the diet to be more varied and nutritious.

Food consumption pattern

There was no significant difference in the patterns of forgotten food consumption between coastal areas (Pucung) and mountainous areas (Mertelu), except for the uncommon aquatic

animals. Respondents in Pucung consumed aquatic animals more often than people in Mertelu. The most consumed types of insects were grasshoppers and caterpillars (including the cocoon from teak and iron tree). Grasshopper is a type of insect that is widely consumed because it is easy to find and catch, and there is no need to buy it, so it is an alternative side dish in *Gunungkidul* which is cheap. The processed grasshopper as a side dish in *Gunungkidul* is quite simple; it is only fried with salt as the seasoning. *Gunungkidul* is well known as grasshopper eaters (as daily food), but there are still many people who are reluctant to try because of their unusual appearance.

Types of forgotten foods originating from fish are divided into two groups: marine- and freshwater- fish. Some commonly consumed marine fish were *panju* fish, *layur* fish, and *binocular* fish. This was while the freshwater fish were *wader*, *cethul*, and *keting*. However, these freshwater fish were not found in the SQ-FFQ results. Only sea fish were found in the survey result. These fish species are classified as forgotten foods because they are rarely available in the market and are not yet commonly cultivated.

Benguk *Tempe*h and koro *Tempe* were the most consumed foods, but the people of *Gunungkidul* prefer the common fermented types, *i.e.* tofu and soybean *Tempe*h because processing of forgotten foods requires more complicated handling. For example, it requires immersion of benguk beans for three days to reduce the toxins. In addition, some fermented food has unpleasant sensory (bitter and unpleasant aroma).

Discussion

This study revealed two main findings: food security status among the poor households living in food-insecure area of *Gunungkidul*, Yogyakarta – Indonesia, and how the forgotten foods contribute to covering the energy and protein requirements of the respondents. Almost half of the subjects (48%) living in this area are food insecure, with more than 60% food expenditure and the energy sufficiency of less than 80%. This high prevalence of food insecurity indicated that their household's

available food did not sufficiently provide for their daily needs. They can not also afford to spend more money to get more food to cover their daily energy needs.

The findings in this study indicated that most cases had low education and lived below the poverty line (99%). These conditions led to low purchasing power. This condition would further reduce their food accessibility. Indeed most of them are farmers who produce foodstuff, but the majority are not land owners. The level of education, occupation, income and food/non-food expenditure are essential to observe how much the community has food insecurity and how it utilises local food in socio-cultural environment (Bene *et al.*, 2021). Household income determines purchasing power, and this purchasing power reflects food accessibility of the household. A higher household income indicates a higher purchasing power and easier access to food (Bene *et al.*, 2021).

The assessment indicates that the government's movements on these subsidized-rice recipients in *Gunungkidul* are already the right target. The fact that the protein intake among the studied population was also insufficient, makes the subsidy more appropriate to be not only source of energy and carbohydrate like rice, but also source of protein. A subsidy program on protein sources would be appropriate to improve health and nutrition status among the subjects, particularly the mothers (pregnant and lactating) and under-five children. This situation was similarly recognized in other countries (Cunningham *et al.*, 2021). Nutritional assessment among the toddlers reveals that there exixts the double burden of malnutrition among toddlers of poor household. Not only underweight toddlers but also the overweight ones were found on the study site. This profile proves that there is imbalance of diet among the children and there are demands for further intervention for healthier generation.

This study revealed that conventional food only covered energy and protein sufficiency below the 80% requirement level (**Figure 2**). Some

forgotten foods like aquatic animals and edible insects enabled the subjects to support the protein intake beyond the 80% level of requirements. The identified local forgotten foods (Palupi *et al.*, 2020) seem to have the potential to cover the food-insecure condition in *Gunungkidul* (Desire *et al.*, 2021). Even they might help the poor household enhance their protein intake since often those forgotten foods are cheap or can be obtained freely from the surroundings. Moreover, the issue of global warming makes these forgotten foods an excellent alternative since some species are able to survive at higher temperature and low water intake (Govorushko, 2019, Lampariello *et al.*, 2012, Oyeyinka and Oyeyinka, 2018, Sade and Peleg, 2020).
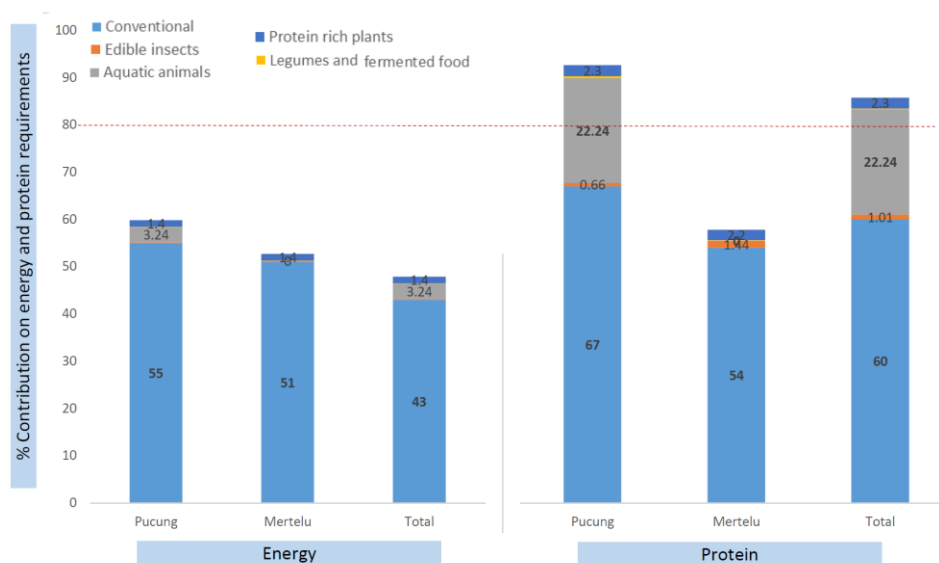
Figure 2. Contribution (%) of some forgotten foods to the energy and protein requirements.

The complete picture of social economic and food security status also revealed that the study on forgotten food as the future protein alternative, will be better than this study. However, this study could be overestimated since it did not take into account the available food from their stock pile. The villagers habitually preserve some dry cereals they keep after the harvest. Some farmers also implement "pala pendem," planting tubers sufficiently, which will be harvested if only the cereals are completely consumed. The tubers were harvested gradually based on their daily needs. In this case, the food is available but the energy intake is insufficient, and it could be stated as "lack of food." Therefore, nutritional education becomes the leading solution.

Nevertheless, the protein intake of the pareicipants was insufficient, which was less than 80% of the daily needs. Therefore, the alternative protein source could be an appropriate solution to cover the community's food security.The main obstacle to using this forgotten food is consumer's preference, particularly the young generation who did not prefer to consume forgotten foods as their meals (Palupi *et al.*, 2020). A public campaign about the functional properties of forgotten foods supported by advance sustainable production and processing might be a way to connect these forgotten foods with food-insecure households and other community's nutrition and health problems (Patel *et al.*, 2019, Possidonio *et al.*, 2021). However, this study proved that food culture refers to eating those forgotten foods in *Gunungkidul* which should be preserved like other original eating culture in other Indonesian cultures, e.g. eating raw vegetables among Sundanese for better vitamin A intake (Amrinanto *et al.*, 2019). Some other positive food culture campaigns for

preschool and elementary children might lead to the community's preference for forgotten foods more effectively. Supply and demand, together with supporting policy, become the key point in returning these forgotten foods.

Forgotten foods are not only protein alternatives but also a supporter of regional economic development. The local government might promote small and medium enterprises to use indigenous knowledge for producing forgotten foods as a special local identifier. Community, industry, and researchers might further collaborate to improve an innovative technology for promoting the forgotten foods, not only on the sustainable production system, but also on the innovative processing to make these foods more acceptable, and lead to longer life, nutritious food, and less un-demanded compounds.

The study has several limitations and strengths. The limitations include a relatively small sample size of 240 households, which may limit the generalizability of the findings, and the geographic scope, as it was conducted in two specific villages in Gunungkidul, Yogyakarta, which might not represent other regions. The reliance on self-reported data through interviews and questionnaires may introduce bias or inaccuracies, and as a cross-sectional study, it captures data at a single point in time, which may not reflect changes or trends over time. On the other hand, the study's strengths include its focus on forgotten foods (edible insects, aquatic animals, indigenous plants) as sustainable protein sources, providing a potential solution for food security in food-insecure regions. It also comprehensively assessed food security status, socio-economic characteristics, food consumption behavior, and nutritional and health status of children and mothers, offering a holistic view. The study's relevance to the local context, particularly in addressing food insecurity in Gunungkidul, provides directly applicable insights. Additionally, the findings suggest practical interventions to improve food security and nutrition, such as promoting the consumption of locally available, nutritious, and sustainable protein sources.

Conclusion

Most of the participants in *Gunungkidul* live under the poverty line and have a food -insecure status. The nutritional assessment also indicated that their energy and protein intake was below the required level. Some forgotten foods like aquatic animals and edible insects provided a significant daily protein intake. A preference shifting regarding those forgotten foods seems to become one barrier to this contribution. A public campaign about the functional properties of those forgotten foods supported by advance sustainable production and processing might be a solution. Therefore, these forgotten foods might be an alternative to a future challenge in supporting human well-being. However, this study is an early investigation. Further study on the whole chain food system's correlation with basic nutrition, production, cultivation, broader community acceptance, clinical nutrition, advanced product development, national impact, and global protein demand would be an excellent future establishment. A related study on food security in other regions and an investigation into some alternative solutions are also highly recommended to uncover the people's actual food and nutrition security status.

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Conflict of interest

He authors declared no conflict of interests.

Authors' contributions

Conceptualization and methodology of the research was done by Palupi E, Anwar F, Tanziha I, and Khomsan A, Validation and investigation was carried out by Palupi E, Anwar F, and Tanziha I. Resources were retrieved by Khomsan A, Anwar F, Tanziha I. Data curation was done by Gunawan MA and Khomsan A. Draft was prepared by Palupi E, Tanziha I, Gunawan MA, and Khomsan A, and all the authors read and approved of the final manuscript.

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