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Classification of Daily Food Sets in an Agro-Pastoral Society in North-Central Namibia: A Comparison of Cluster Analysis and Two-Way Indicator Species Analysis

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Abstract Daily food surveys to clarify the patterns of local food cultures are typically used to record daily food consumption and understand local food culture. Previous studies used survey data obtained mainly by calculating the frequency of occurrence of each food item, dish, or combination of specific items. To understand African food culture by focusing on the combinations of food items and to show the different perspectives that are free from the subjectivity of the empirical study, this study examined the application of two classification methods to a food survey dataset obtained through a food survey in a rural village in north-central Namibia. To arrive at a better classification method, the author attempted to use two representative classification methods, cluster analysis and two-way indicator species analysis (TWINSPAN), to classify the same food dataset, focusing on the combination of dishes. Differences between the two sets of results were examined. Both methods extracted four major groups with some subgroups that abstracted some features of the food culture of Owambo. Although there were some differences in classification between the two methods, the authors found no obvious trends when using those two methods in this study. The classification of combinations of food items presented in this research could be applied to good effect by other studies on food culture.

Keywords: Agro-pastoral society; Cluster analysis; Daily food survey; Food culture; Namibia; Two-way indicator species analysis (TWINSPAN).

Introduction

Local food culture is formed dynamically through the influence of the natural environment, plants, and animals that inhabit the region, people's livelihoods, and economic changes. Therefore, understanding local food culture may help clarify people's livelihoods and the region's features, and comprehend rapid changes amid globalization.

An overview of the characteristics of African food cultures has been provided in previous studies. Those approaches have been used to understand Africa's food cultures (e.g., Van der Post 1970; Osseo-Asare 2005; Ogawa 2004; Ankei *et al.* 2016). For example, Osseo-Asare (2005), in a book titled "Food culture in sub-

Saharan Africa," described the foods eaten in western, southern, eastern and central Africa and their historical backgrounds, and McCann (2009) described how the ingredients, practices, and varied tastes of African cuisine comprise a body of historically gendered knowledge of the African landscape.

In African studies on ecological anthropology in Japan, empirical findings have been accumulated from daily dietary surveys and quantitative studies to clarify human adaptation to the environment. The daily food survey method was used to assess daily food consumption in the region. This method involved researcher observations and interviews with household members or members of villages where the researcher stayed, and recorded the contents of daily meals. In those cases, household members were given notebooks and asked to record the content of their daily meals. This type of survey has been conducted in the fields of cultural anthropology, ecological anthropology, and human geography as part of live-in field surveys conducted in villages.

Daily food surveys help elucidate the energy flow of human populations in ecosystems. Previous studies have measured the amount of energy expended on subsistence and other activities, the resource energy obtained through such activities, and the energy distribution among group members. Nutritional studies and comparisons between the regions were also conducted. In the African context, Tanaka (1971) examined the hunter-gatherer diet of the Batswana (the people of Botswana), and Ichikawa (1982) studied the Mbuti Pygmies of the Congo. Sato (1992) explored the labor input and diet of Rendire pastoralists in Kenya. Kakeya (1994) examined the labor input and production of Bemba, a farming community in Zambia. Overall, dietary surveys clarify the status of the local food culture and help one understand local livelihoods and social structures.

Data obtained through daily food surveys describe the local food culture by calculating the frequency of consumption of each foodstuff or dish. This method allows the depiction of the characteristics of the local diet by dishes and ingredients that appear at high frequencies. However, to understand the cultural aspects of food-eating habits, the combination of main and side dishes must be analyzed. Komatsu (1996) clarified this point by conducting a dietary survey in villages M and L in southeast Cameroon, focusing on food combinations, taste preferences, and food choices. This proposed approach revealed the existence of two sets of key dietary ingredients in villages, i.e., bitter cassava and plantain banana (Komatsu 1996). The results show that, by focusing on combinations, a study may typify and understand the local food culture and capture changes in food combinations. However, most previous studies have focused on specific food ingredients and the frequency of consumption of these and other food ingredients. By contrast, dietary surveys may use different data and statistical methods to create typologies.

To objectively classify the dataset of food combinations, this study applied statistical classification methods to the dataset. This study applied two representative classification methods for classifying the presence or absence of datasets: cluster analysis and indicator species analysis (Mineta *et al*. 2005). The advantage of these methods is that they can show trends in a diet set beyond the limits of intuition-based classification through an analysis that is as free from subjectivity as possible. This differs from the findings of previous studies. However, no

previous studies have examined the best method to classify food datasets; therefore, this study compares the results of classifications.

Cluster analysis classified the dataset into "clusters," and indicator species analysis is an ordinalization method to coordinate data. Both methods were used to classify the multiple quantitative and categorical variables. Cluster analysis is an aggregation method that groups similar data. In contrast, indicator species analysis is a divisive method that divides the data into smaller groups (Mineta *et al*. 2005). This study applied both cluster analysis (hierarchical clusters) and two-way indicator species analysis (TWINSPAN) to the same dietary data, examined the differences in the results, and discusses the significance of food combination classifications.

Cluster analysis investigates the distribution of multiple similar groups of scattered data (similarity) and groups them into larger groups based on the similarity index. This study adopted this approach to handle categorical variables. One advantage of this approach is that the hierarchical structures of small and large groups can be easily understood from the dendrogram obtained from the analysis.

The TWINSPAN is a classification method proposed by Hill (1979). It is a statistical analysis method that is often used to classify habitats and distribution of biological communities. Compared with cluster analysis, this method targets all scores from the beginning, making it less susceptible to chance fluctuations in individual small scores, and correctly reflecting the original character of the dataset (Mineta *et al*. 2005). In addition, by examining the indicator species and the composition of the groups, this approach allowed consideration of the characteristics of each group (Mineta *et al*. 2005).

As mentioned above, this study investigated the local food culture and its changes, focusing on the combination of dishes in dietary survey data obtained from a rural village in north-central Namibia. Survey data were classified using cluster analysis and TWINSPAN. These methods were used to verify what differences arise when the same dataset was analyzed using different approaches, and what kind of local food culture and changes may be deduced from the classification results.

Materials and Methods

I. Study area

The author conducted a field survey in the village of Uukwangula (referred to as Village U, henceforth) in the Oshana Region, located in the north-central part of the Republic of Namibia. The study area is located in the middle reaches of the Cuvelai water system, which stretches from southern Angola to northern Namibia (Mendelsohn *et al*. 2013). The plains slope gently from north to south, and seasonal rivers are distributed in a network (Figure 1). The region lies in a semi-arid environment, with an average annual precipitation of 300–500 mm, which is concentrated during the rainy season from December to March. During years of high rainfall, flooding occurs along seasonal rivers. Precipitation varies

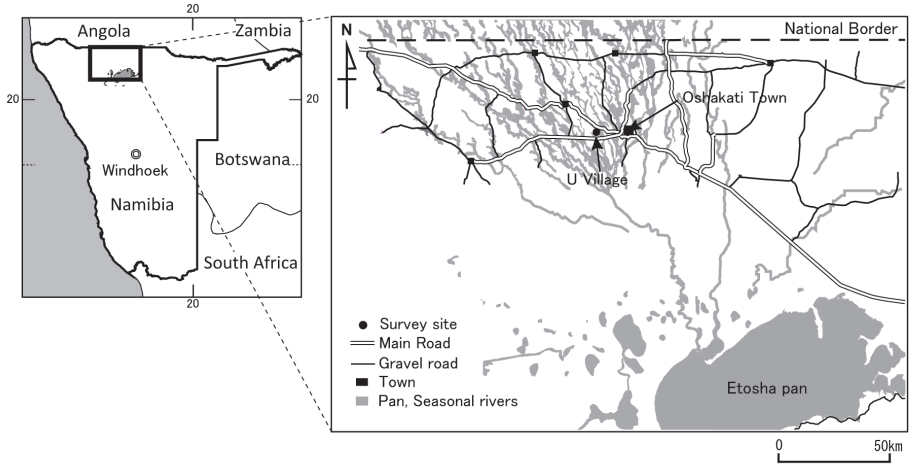

Figure 1 Survey site.

significantly from year to year, and the region frequently experiences droughts and heavy rainfall. A national emergency is declared when severe damage occurs and foodstuffs, such as rice and canned food, have to be distributed.

The Owambo agro-pastoralists, who account for nearly half of Namibia's population, live in this region. "Owambo" is a generic term that includes several subgroups, such as the Kwanyama, Ndonga, Kwambi, and Nbandja. Their ancestors are thought to have migrated from south of western Zambia around the Zambezi River, through Angola, and settled in north-central Namibia during the 16th century (Williams 1991).

The population of the Oshana Region in 2001 was approximately 160,000, with a population density of 18.7 persons/km^2, making it a relatively densely populated area in Namibia (Central Bureau of Statistics 2003). Most Village U residents belong to the Kwambi subgroup. Kwambi formed a kingdom near the center of the reticulation zone, and is the third largest subgroup in terms of population. They set up homesteads in the Cuvelai water system and cultivated several hectares of fields around their homesteads. Villages are scattered, with houses separated by several hundred meters, and each household is characterized by a high degree of independence in terms of livelihood activities and economy. Seasonal rivers are not used for agriculture, but mainly as grazing land and waterholes for livestock.

The Owambo engage in multiple livelihoods, combining agriculture and pastoralism with gathering wild grasses and edible insects, fishing, and urban migrant work (Fujioka 2016; Fujioka *et al*. 2020). Many have recently moved to urban areas, and large supermarkets have emerged in cities near rural areas. The staple food of the Owambo is hard porridge (*oshithima* in the local language), made by boiling and kneading pearl millet flour in hot water. Its side dishes include cow's milk (sour milk), meat, fish, and insects. Drinks (*oshikundu*), composed of a mixture of pearl millet flour, germinated sorghum seeds, and fermented sorghum, are also commonly consumed.

The Owambo rely on rainwater for agriculture. In December, when the rainy

season begins, families plow fields with a plow pulled by a donkey or tractor, the latter having been introduced around 1980. The entire family works together to sow seeds. The largest land area is planted with pearl millet. Farmers often work together to plow fields. With the onset of the dry season in May, crops are harvested, threshed, and stored in granaries. Harvested crops are primarily used for subsistence, and the surplus from a good harvest can be stored for several years. In addition to farming, the Owambo are pastoralists. Their main livestock species are cattle and small animals (goats and sheep). Cattle are used for milking and food, whereas small livestock are used as food.

The food culture of the Owambo is thought to have been largely influenced by the colonial rule in Namibia. Namibia became a German colony in the late 19th century, and was ruled by South Africa during apartheid after World War I. Under colonial rule, kings and chiefs—leaders of ethnic groups—were eliminated and incorporated into the colonial system. The kings and chiefs were responsible for providing food assistance to households lacking food during drought events. However, those social institutions were lost during colonial rule. Many rural people migrated to cities to work, and were exposed to the suzerain state's food culture and urban lifestyle. Even after independence in 1990, working in cities or staying in boarding houses while attending school, was common practice. With the development of cities, large supermarkets have begun to expand into the countryside.

Village U is a suburban village located approximately 10 km from Oshakati, the main city in Oshana, and is strongly influenced by the city. Residents may reach the town relatively easily by hitchhiking or sharing cab, usually returning to the village after the shopping excursion.

II. Data

A field survey was conducted in Village U from September 2004 through April 2005. Preliminary information on the area's food culture was obtained through participatory observations, and from interviews with 30 of the 97 households in the village in 2002 and 2003. The author interviewed the heads and spouses of all 30 households to glean information regarding their livelihoods, such as the size of their fields, number of livestock, means of earning cash, and access to food. Information was also collected on the types of food and cooking methods used by the women responsible for daily cooking. In addition, the author interviewed the village's older adults to clarify their past livelihoods and food culture, and how those have changed over the past few decades.

This study has conducted dietary surveys on eight households since 2004. In the survey on meals, households were asked to record the contents of their meals and the methods of obtaining foodstuffs in notebooks, which were checked every one to two weeks. This strategy allowed the researcher to determine the food combinations that were consumed by each household for every meal. Beverages were not included, except for sour milk, because it was a side dish. Snacks and light meals were excluded from the study.

Meals are generally eaten at home, but they are sometimes consumed in other

households or at a tavern near the village. Interviews and notes were limited to meals consumed by each household that formed part of the study, and excluded food and beverages consumed by other households or villages. A previous study (Fujioka 2016) had also assessed the frequency of the occurrence of each food item, and how they had been purchased. This study used only three households' data for December 2004 and January 2005 from that dataset. In contrast, this study employed a different methodology from the one used in a previous study by the current researcher. The three target households (households A, B, and C) were classified into three economic strata (high-, middle-, and low-income households), based on the income information of each household, and selected households with typical dietary trends from each stratum. The target months were December and January because they included meals during both dry and rainy seasons. The study period covered 62 days, and each household consumed 186 meals comprising breakfast, lunch, and dinner (a total of 558 meals for all three households). There were 42 missing data points (households A:3 and C:39), and 127 missed meals (households A:41, B:52, and C:34). This study addressed 389 meals (household A:142, household B:134, and household C:113) (Table 1).

III. Analysis

As mentioned above, the data set on meals was classified using cluster analysis and TWINSPAN. The dataset used for the analysis reported the categorical variables (presence or absence) for 16 food items, with 389 meals included in the analysis.

Table 1 Details of the dataset

Number of meals		389
Number of foods		16
The number of meals in each household	Household A	142
	Household B	134
	Household C	113
The number of no meals (the case of three meals per day) [a)]	Household A	41
	Household B	52
	Household C	34
The number of meals of incomplete data	Household A	3
	Household B	0
	Household C	39
The number of meals with one, two, and three food items	One food item	100
	Two food items	282
	Three food items	6
	Four food items	1

a) The number of no meals if all target days have three meals.

Hierarchical clustering with the group average method, using the correlation distances among samples, was adopted, and the clustering results are shown as a dendrogram. Statistical analyses were performed using the SPSS Statistics software (IBM, version 24).

The TWINSPAN was conducted using the statistical analysis software PCord. The food types for all mealtimes were coordinated using correspondence analysis (alternating mean method). The indicator food types were extracted, awarding a positive or negative score to the unevenly distributed indicators for food types, and dividing each mealtime in which the indicator for food types appeared, into two groups (for details, see Mineda *et al*. 2005). This procedure was repeated until no further divisions were possible. The minimum number of groups was set to three, the maximum number of indicator species to five, and the maximum number of splits to six. The first six splits focused on identifying the overall classification trends. The final group of divisions was given a category name, and a table of endemism was created, based on how the analysis results were organized in the study of biological communities. The data were classified as the frequency of occurrence of each food item in each category as a percentage, and organized into the following six levels: V = 80% or more occurrences; IV = 60–79% occurrences; III = 40–59% occurrences; II = 20–39% occurrences; I = 1–19% occurrences; and blank = no occurrences).

Results

I. Owambo's daily food

Interviews with 30 households in Village U showed that village residents generally ate two meals per day: lunch (*omusha*), and dinner (*ulalelo*). Breakfast was simple, often including only a drink (*oshikundu*). However, some households also ate bread (*omboloto*) and rice (*olushi*, Figure 2) or other foods purchased from the market. A typical meal consisted of one staple and one side dish, typically porridge (*oshithima*, Figure 3), boiled meat (*onyama*), wild herbs (*omboga*), fish (*eeshi*), or sour milk (*omashini*).

Figure 2 *Olushi* (rice)

Figure 3 *Oshithima* (porridge, right) and *onyama* (meat)

Meals are generally shared by extended families living in the same homestead, and the members of those families were relatively fixed. Women typically cooked and decided on the menu for meals. The main ingredient, pearl millet, was stored in a granary at the homestead, and the grain was milled and used as needed. As a side dish, they obtained milk and sometimes slaughtered livestock for meat. Fish were obtained by fishing seasonal rivers. Wild plants and edible insects, among others, were also eaten. Foodstuffs were often obtained through private procurement, gifts, and bartering. In such cases, high-income households that owned livestock played an essential role as livestock providers in the community. In many cases, food ingredients were purchased from towns.

Figure 4 shows the frequency of food items for this study's meal sets, using the same method as Fujioka (2016). Of the 389 meals, only one item was eaten 100 times, two items 282 times, three items six times, and four items once, indicating a trend toward eating one or two items more often. Food surveys identified 686 food items, which were divided into staples and side dishes, of which 411 were classified as staples and 275 as side dishes. The most common staple food was pearl millet (61%), followed by rice (20%), bread (11%), macaroni (4%), potatoes (3%), and boiled cowpeas (1%). Among side dishes, 34% were beef, 32% wild grass, 12% fish, 9% goat meat, 9% chicken, 1% pork, 1% sour milk, 1% duck meat, 1% beetle larvae, and 0.4% canned fish.

The staple food, *oshithima*, is similar to the hard porridge made of maize (*shima*) eaten in southeast Africa, including eastern Namibia and Zambia. It is made by kneading powdered pearl millet in hot water, sometimes with a small amount of salt and oil, but it is never seasoned. Other staple foods, such as rice and potatoes, are not grown in this region, and all staple foods recorded in the dietary survey were purchased from supermarkets. Rice is not ground into flour,

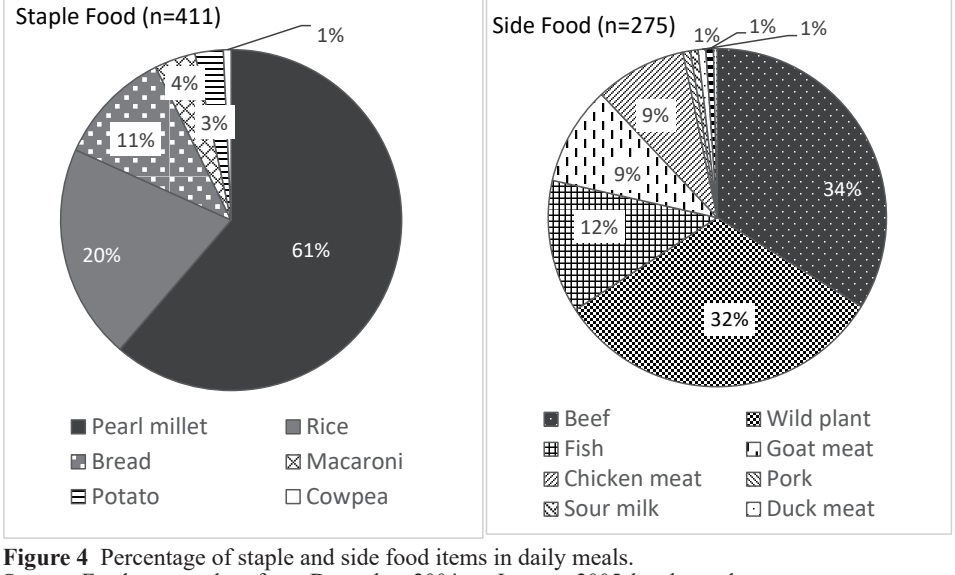

Figure 4 Percentage of staple and side food items in daily meals.
Source: Food survey data from December 2004 to January 2005 by the author.

but is eaten as a grain cooked in water with a small amount of salt and oil. Potatoes were boiled in a small amount of salt or oil. Bread and macaroni were also purchased, and bread was eaten as is, whereas macaroni was boiled with a bit of salt and oil. Purchased ketchup was sometimes used as a condiment to rice, macaroni, and potatoes. There were two ways to eat cowpeas in this region: drying beans or boiling them in their shells, and eating them with salt when they have just been harvested. The dietary survey only provides evidence of later eating habits.

Meat (beef, chicken, goat, pork, and duck), fish, and wild plants were eaten as side dishes; boiled or cooked, with a small amount of salt and oil. Occasionally, seasoning (such as soup stock) was purchased from supermarkets and used in cooking. Meat was obtained by slaughtering livestock that had been purchased from supermarkets or street markets, or received as a gift. The fish were mostly finned catfish caught in seasonal rivers around the village; however, they sometimes were purchased from supermarkets. Canned fish was generally purchased from supermarkets. Sour milk, a naturally fermented milk from domestic cows, could be self-supplied or gifted from other households. Beetle larvae accumulated in the soil of livestock enclosures during the rainy season, and households collected them by digging into the soil with a hoe, and then gutting and stir-frying them in oil.

II. Classification of food sets by cluster analysis

Figure 5 shows a dendrogram of the cluster analysis results. As indicated, 29 smaller categories were extracted from the subcategories. To assess the correspondence with TWINSPAN, as described in the next section, combinations with the number of categories that may have the same number of combinations (arrow positions in Figure 5), were examined. Consequently, 16 categories were selected, with subcategories numbered from I to IV for convenience, as shown in Table 2.

The primary categories, shown in brackets on the left-hand side of Figure 5, are I, II, III, and IV. Primary category I indicates a combination of pearl millet and a side dish. Category II features combinations that lacked pearl millet, and which consisted mainly of rice or macaroni. These two combinations exhibited significant differences in staple foods. Category III only includes cowpeas (boiled), and category IV only contains bread; these two meals contained only one food item.

In primary category I, subcategory I-1 includes pearl millet or wild plants; pearl millet and chicken feature in I-2; pearl millet and fish in I-3; and other foods (Table 2). The same applies to category II, but combinations of three or more items were extracted as separate categories, i.e., subcategories II-3 and II-4.

Table 2 shows these subcategories' incidence frequency. The most common subcategory was I-1 (pearl millet and wild plants; 26%), followed by I-7 (pearl millet and beef; 25%). Approximately 74% of the observations belonged to category I (pearl millet and other foods), and approximately19% to category II.

III. Classification of food sets by TWINSPAN

Using TWINSPAN, the meal sets were divided six times according to the indicator species, resulting in 16 groups (Table 3 and Figure 6). In the division stage 1, the set was divided into two groups: Group A, which only ate boiled cowpeas as the indicator species, and the others. In division stage 2, the set was divided into two groups: group B, which ate bread as the indicator species, and the others. In the third stage, the indicator species included pearl millet, wild plants, and rice. The samples were divided into two groups: Group C, comprising pearl millet and wild plants, and Group D, comprising rice.

After division 4, group C was further divided into two subgroups, C1 and C2, based on the presence or absence of wild plants in division 4. At division stage 5, C1 was split into groups C1 and C2 based on the presence or absence of beetle larvae, and C2 based on the presence or absence of fish. At division stage 6, the group lacking beetle larvae in C1 was divided into C1-2 and C1-3, based on the presence or absence of pearl millet, and the group lacking fish in C2 was split into C2-2 and C2-3, based on the presence or absence of goat meat.

Similarly, group D was divided into D1, comprising macaroni, chicken, and goat meat, and D2, which contained other food items at stage 4. D1 was split

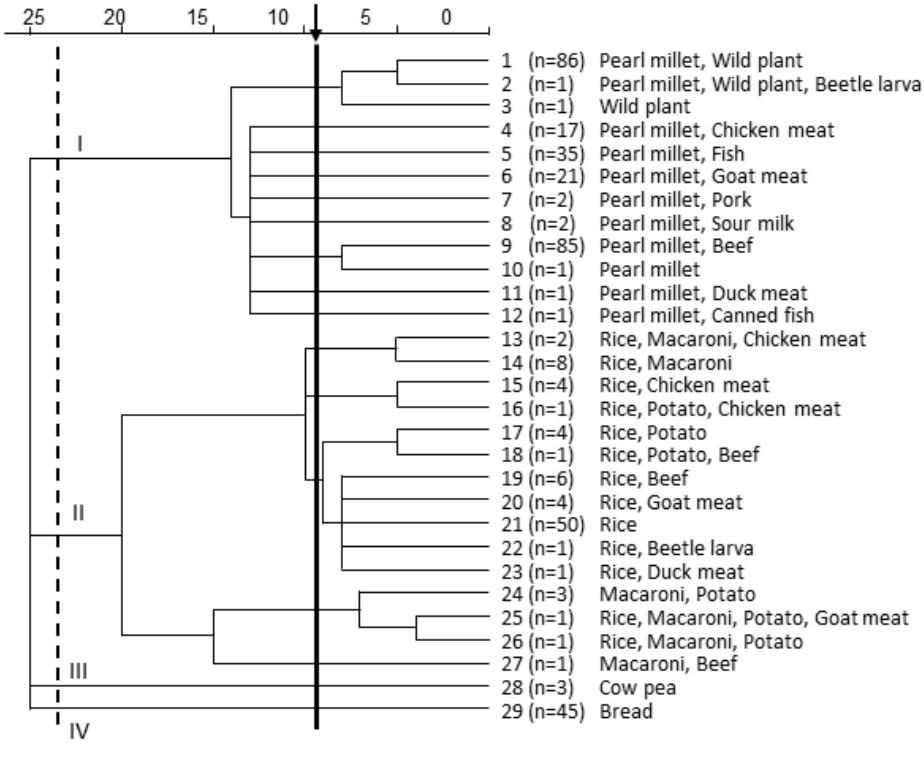

Figure 5 Dendrogram of cluster analysis.
Source: The author conducted a food survey from December 2004 to January 2005.

Table 2 Cluster analysis results

Subcategories	I-1	I-2	I-3	I-4	I-5	I-6	I-7	I-8	I-9	II-1	II-2	II-3	II-4	II-5	III	IV	Total Number
Number of meals	88	17	35	21	2	2	86	1	1	10	5	67	5	1	3	45	389
Name of food	Number of occurence																
Pearl millet	87	17	35	21	2	2	86	1	1								252
Fish			35														35
Wild plant	88																88
Pork					2												2
Canned fish									1								1
Sour milk						2											2
Rice										10	5	67	2				84
Macaroni										10			5	1			16
Potato											1	5	5				11
Cowpea															3		3
Bread																45	45
Beef							85					7		1			93
Chicken meat		17								2	5						24
Goat meat				21								4	1				26
Duck meat								1				1					2
Beetle larva	1											1					2
Number of foods	176	34	70	42	4	4	171	2	2	22	11	85	13	2	3	45	686
Percentage of the meals in total number of meals (%)	25.7	5.0	10.2	6.1	0.6	0.6	24.9	0.3	0.3	3.2	1.6	12.4	1.9	0.3	0.4	6.6	

Note: The cluster analysis results show the subcategories of meal types and the number of occurrences of each food item.
Source: The author conducted a food survey from December 2004 to January 2005.

Table 3 TWINSPAN results

Subcategories	A	B	C1-1	C1-2	C1-3	C2-1	C2-2	C2-3	D1-1	D1-2	D1-3	D1-4	D2-1	D2-2	D2-3	D2-4	Total Number
Number of meals	3	45	1	86	1	35	21	109	7	4	5	9	7	4	1	51	389
Name of food									Consistency								
Cow pea	3																3
Bread		V															45
Pearl millet			1	V		V	V	V									252
Rice									V	4	III	V	V	4	1	V	84
Wild plant			1	V	1												88
Macaroni									II		V	V					16
Chicken meat								IV	V								24
Goat meat							V			4	II						26
Beetle larva			1													I	2
Fish						V											35
Beef								IV				I	V				93
Potato									I		V		I	4			11
Duck meat								I							1		2
Pork								I									2
Canned fish								I									1
Sour milk								I									2
Number of Foods	3	45	3	172	1	70	42	217	17	8	13	18	15	2	2	52	686
Percentages of the meals in total number of meals (%)	0.8	11.6	0.3	22.1	0.3	9.0	5.4	28.0	1.8	1.0	1.3	2.3	1.8	1.0	0.3	13.1	

The TWINSPAN results show the subcategories of meal types and the number of occurrences of each food item. Category V exhibits more than 80% occurrence in each category, category IV 60–79%, category III 40–59%, category II 20–39%, and category I 1-19%. Roman numerals are used for the categories in which the total number of meals is more than five times; Arabic numerals identify all other categories. Blank means no occurrence in each category. Dark grey categories show the indicators of the three division stages, and light grey categories show the indicators of the fourth division stage.

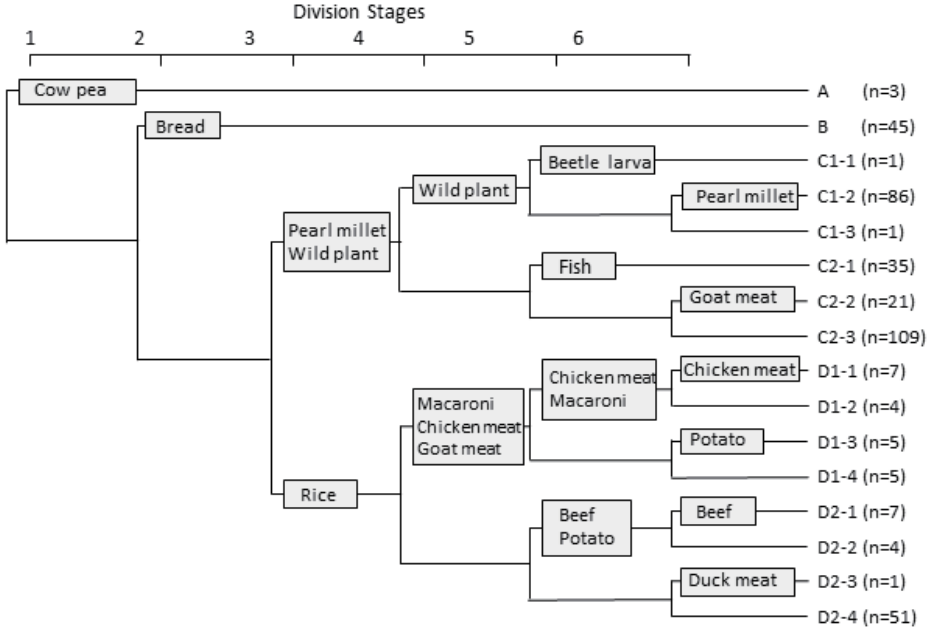

Figure 6 Groups by indicator foods using TWINSPAN.
Source: The author conducted a food survey from December 2004 to January 2005.

into groups comprising chicken, macaroni, and other food items at division stage 5, with D1-1, D1-2, and D1-3 being defined by the presence of chicken and potatoes at division stage 6. D2 was divided into groups characterized by beef, potatoes, and other food items in division 5, and D2-1, D2-2, D2-3, and D2-4 were defined by the presence or absence of beef and duck meat in division 6, respectively.

Discussion

I. Differences of results between the two classification methods

Using data from a daily food survey conducted in Village U in north-central Namibia, this study examined the differences in the results of the extracted clustering groups. The results show that, for the top categories, cluster analysis resulted in category I (mainly combined with pearl millet), category II (lacking pearl millet and consisting of rice or macaroni), category III (boiled cowpeas), and category IV (bread), whereas the binary indicator species analysis resulted in subgroups C (pearl millet and wild plants) and D (rice). These results are in alignment with those of the index species analysis.

However, differences in the classification between the clustering and ordination methods were observed around the middle classification (Figure 7). For example,

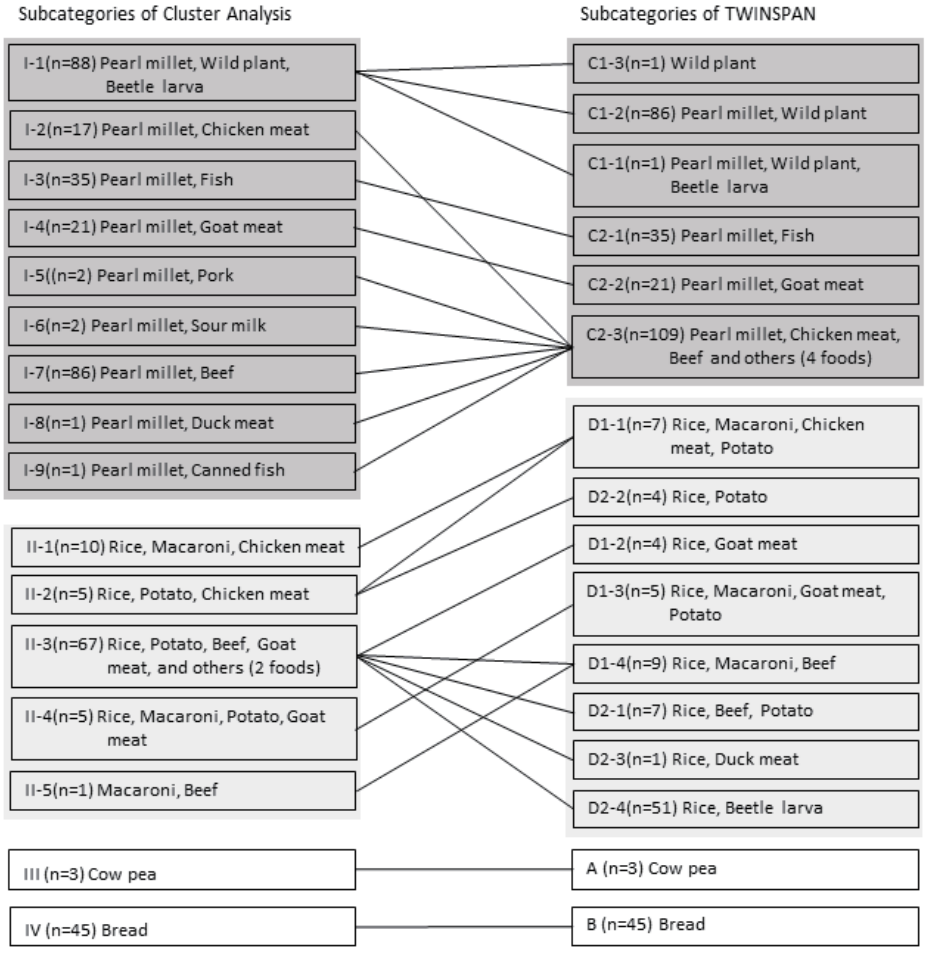

Figure 7 Relation between subcategories of cluster analysis and TWINSPAN.
Note: The categories were extracted using cluster analysis and TWINSPAN, as shown in Tables 2 and 3, respectively.

I-1 (a subcategory of cluster analysis), was divided into C1-1, C1-2, and C1-3 (subcategories of TWINSPAN). C2-3 (TWINSPAN subcategories), were divided into I-5, I-6, and I-7 (cluster analysis subcategories). Owing to the small number of items constituting the set, small variations in the combinations grouped at different stages of the classification process were observed.

Differences were observed in the treatment of meal sets, but the authors found no fixed rule for the differences in trends. These differences might be more pronounced in larger samples. Concerning the study's dataset, the researchers did not identify a unique correct classification method, and subjective judgement was required to choose the method.

II. Advantages of the proposed method

This study attempted to organize daily food survey data based on the frequency of occurrence of each food item and to classify food sets based on combinations. Consequently, the data were classified into several categories based on the combinations of food items. The results were structured and organized from large to small, in line with Komatsu (1996), who classified meal sets in rural villages in Cameroon based on the combination of ingredients, proving the existence of two sets centered on bitter cassava and plantain banana in Villages M and L. However, in Komatsu (1996), the large-category classification items, bitter cassava and plantain banana, were intentionally set by the analyst at the time of classification. By contrast, using cluster analysis or TWINSPAN, this study obtained the classification items statistically, limiting the analyst's subjectivity.

Finally, the analysis revealed several aspects of food culture in the Owambo community. First, regarding meal combinations, some ate only one dish, whereas others ate a combination of the main and side dishes. Cowpeas (boiled) and bread, extracted using both cluster analysis and TWINSPAN, were not combined with other foods. Cowpeas (boiled) featured only three times in this study, but their frequency increased in the latter half of the rainy season, when they were generally eaten for lunch. Bread was also purchased and eaten in this region and was mostly eaten for breakfast, which was not a common habit. The reason for this eating habit could not be ascertained in this study, and the author would need to conduct another survey, such as interviews, to augment the collected data.

Second, the primary category meal sets were divided into two major categories based on the differences in staple foods. The combination of rice, macaroni, and potatoes, among others, represented meals based on purchased foods. In addition, the side dishes combined with these food items were meat (chicken, goat, and beef), mainly combined with pearl millet and rice. Rice was a new food in this region; however, the combination of the staple food (pearl millet) and meat is part of the indigenous food set. Therefore, the combination of rice and meat may be easily accepted.

Both wild plants and fish were only eaten as side dishes in combination with pearl millet (other ingredients exhibited a similar tendency, but were excluded from the analysis because of their low incidence). Macaroni and potatoes were consumed only in combination with rice. Although the limited information from the dietary survey cannot be considered a general trend for the region, it suggests that some side dishes were combined only with particular staple foods. Food items that were new to the community or purchased in supermarkets, were integrated into daily meals. For example, differences exist depending on whether a food item is eaten solely on its own, as in the case of bread, or in combination with other food ingredients, as in rice. These results suggest that a classification method focusing on combinations may effectively clarify the dynamic aspects of food culture.

Concluding Remarks

The methodology served to identify the characteristics of the local food culture by classifying combinations of food items. It enabled the researcher to examine how newly introduced food items were incorporated into the indigenous food culture, suggesting that this method might be applied to examine the dynamic aspects of food culture.

Because this study aimed to compare the two methods of analysis, the dietary survey data were limited. Therefore, further analyses with a larger number of households and meals are required to determine whether the results indicate a general trend in the food culture of the Owambo community. Additionally, this study did not examine household differences. Hence, differences in the prevalence of extracted food types among households should be examined when considering food diversity in the region.

The present analysis addressed food, but did not analyze ingredients and seasonings. Addressing these aspects may help clarify food transformation in the future. Furthermore, future studies may adapt this method and extend it to other regions by investigating the similarities and differences in meal sets and food spread across a broader area.

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