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Nutrient profiling of locally available pig feed resources on small-scale farms in the Cape Metropole, South Africa

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Abstract

This study assessed the seasonal availability and nutrient profiles of pig feedstuffs present on small-scale farms in the Cape Metropole, South Africa. Eighty-two feedstuffs (54 in winter and 28 in summer) were collected from 50 small-scale urban pig farms in five low-income, high-density suburbs in the Cape Metropole. There was an association between season and feed category, with fruit wastes and bakery wastes (contributing 36% and 19% of total feed samples, respectively) being the most abundant feedstuffs in summer and winter, respectively. Fruit and vegetable wastes had the lowest dry matter (<25%) and highest crude fibre (>10%) concentrations, regardless of the season. Soybean and milk mix, spinach, and Russian sausage waste had the highest crude protein (31%–48%) and amino acid concentrations in summer. In winter, soybean and fish meal mix, dry commercial feed, and ice cream and cheese mix were the predominant sources of crude protein (31%–35%) and amino acids. Irrespective of season, kitchen wastes containing meat and dairy by-products and bakery wastes containing legume seeds had the highest ether extract (16%–34%) and gross energy (20–24 MJ/kg) values. Spinach and wheat by-products were the richest sources of minerals in summer and winter, respectively. Small-scale farmers in the surveyed areas could use legume grains and vegetable, meat, and dairy wastes as sources of protein, amino acids, and minerals, while kitchen wastes containing meat or dairy by-products and bakery wastes containing legume seeds could be used as energy feedstuffs to formulate customised, cost-optimised, and balanced homemade diets for pigs.

Keywords: balanced diet, feedstuff, nutrient composition, small-scale pig production

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Introduction

Globally, feed costs account for 60% to 80% of total pig production costs (Visser, 2004; Okello *et al.*, 2021) and are significant profitability determinants for these enterprises (Pierozan *et al.*, 2016). Feed provides pigs with nutrients such as energy, protein, minerals, vitamins, and water for body maintenance, growth, reproduction, and lactation (Pomar *et al.*, 2021). A balanced nutritional profile and constant availability of nutrients are critical for optimal pig production (NRC, 2012). However, this is frequently lacking, particularly on small-scale farms in sub-Saharan Africa, where pigs are often offered inadequate, excessive, or imbalanced nutrients (Mathobela *et al.*, 2024a). Seasonal scarcity and high costs of quality feeds are the main reasons small-scale pig farmers in sub-Saharan Africa adopt such inappropriate feeding practices (Roelofse, 2013; Ouma *et al.*, 2015). A lack, excess, or imbalance of nutrients negatively affects pigs' ability to convert feed into wholesome meat for human consumption (Zijlstra & Beltranena, 2022).

There is an increasing trend of low-income residents in sub-Saharan Africa's urban areas raising pigs on small-scale farms to meet their nutritional, financial, and socio-cultural requirements (Jacobson *et al.*, 2014; Mathobela *et al.*, 2024a). In this sub-region, pigs on small-scale urban farms mostly roam homesteads, scavenging for feed. They are also offered fodder cut from public lands or non-conventional feed resources (NCFR), particularly kitchen and agro-industrial wastes (Mbuthia *et al.*, 2015; Molotsi *et al.*, 2021). Despite the competitive advantage that small-scale urban pig farmers have compared to small-scale rural farmers regarding proximity to commercial feed companies and access to abundant and cheap former food products, kitchen wastes, and agro-industrial wastes, feed scarcity remains a challenge (Thys, 2006; Giromini *et al.*, 2017; Mathobela *et al.*, 2024a). Feed scarcity on these farms is not only due to the high cost of commercial feeds but also the lack of low-cost, energy-efficient technologies and insufficient farmer knowledge to process NCFR. This knowledge gap limits the ability of farmers to formulate customised, cost-optimised, complete, and balanced homemade diets (Pinotti *et al.*, 2021). The feed scarcity challenge in urban areas is exacerbated by intense land, water, and labour competition between feed production and other commercial activities (Jacobson *et al.*, 2014; Twine & Njehu, 2020). More critically, the availability, nutrient composition, and feeding value of most NCFR commonly fed to small-scale farmed pigs in sub-Saharan Africa's urban areas vary with season, source, type, and location (Mathobela *et al.*, 2024a) and have not been evaluated, and thus remain under-exploited.

The evaluation of the seasonal availability and nutrient composition of local NCFR on small-scale urban farms generates information that is important for feed budgeting to ensure a consistent and accurate supply of nutrients. This, in turn, helps minimise feed wastage and ensure the survival of those pig classes most vulnerable to nutrient deficiencies. Furthermore, such information can form the basis for developing customised, least-cost, complete, and balanced homemade diets to optimise pig production for small-scale urban farmers. It could also help these farmers further exploit pigs' ability to efficiently process low-quality and human-inedible NCFR into high-quality pork with minimal environmental and public health impact (Pomar *et al.*, 2021; Zijlstra & Beltranena, 2022; Olsen *et al.*, 2023). Overall, these improvements may provide high and quick returns, thereby shifting small-scale urban-based enterprises towards a sustainable circular bioeconomy (Giromini *et al.*, 2017; Malenica *et al.*, 2023; Mathobela *et al.*, 2024a). The present study evaluated the seasonal availability and nutrient composition of locally available feedstuffs on small-scale urban farms in the Cape Metropole, South Africa.

Materials and methods

Ethical considerations

Permission to conduct the study was requested and obtained from the Stellenbosch University Research Ethics Committee on Social, Behavioural and Education Research (approval number: REC-2020-17285) and Biosafety and Environmental Ethics (approval number: BEE-2020-18654), as well as from the South African Department of Agriculture, Land Reform and Rural Development (approval number: 12/11/1/4/1/1835 HP) to conduct research following Section 20 of the Animal Diseases Act 35 of 1984 (RSA, 1984). The study was conducted in accordance with Declaration of Helsinki principles.

Study area

The study was conducted in the five low-income, high-density suburbs of IthembaLab (GPS coordinates: −34.020630, 18.711254), Khayelitsha (−34.040539, 18.714261), Mfuleni (−34.008137, 18.675448), Penhill (−33.973532, 18.717577), and Strand (−34.129302, 18.881187) in the Cape Metropole, South Africa. The suburbs were selected based on the number of small-scale urban farms and the pig population size according to the Producer Farmer Register (PFR) database from the Western Cape Department of Agriculture (WCDoA), South Africa (Mathobela *et al*., 2024b). The PFR is a national database on all commercial and smallholder farmers in South Africa that includes information on agricultural activities, infrastructure, farm attributes, and demographics of the farmer. The WCDoA list used included a total population of 383 pig farmers, with 124, 75, 70, 61, and 53 farmers coming from Mfuleni, Khayelitsha, Penhill, Strand, and IthembaLab, respectively (Mathobela *et al*., 2024b). Extension officers and animal health technicians from the WCDoA assisted in selecting the farms based on farmer's availability and willingness to participate in the study. Because of an outbreak of African swine fever in the study area during data collection, some farmers were reluctant to participate, and others had no feed samples as they had lost all their pigs to the disease.

Feed sampling

The pig farmers in the five selected suburbs were previously interviewed about the feedstuffs they use in related studies (Mathobela *et al*., 2024b; Mathobela *et al*., 2025). A minimum of two samples of each product were collected, either at each farm or from different farms after the interviews, based on availability and the farmer's willingness to participate. A total of 82 feedstuffs (54 in winter and 28 in summer) intended for pig feeding were collected using a combination of opportunity (i.e. convenience) sampling, and a census approach. Samples were collected from 50 farms across the five selected suburbs within the Cape Metropole, with 10 farms sampled in each suburb. The possibility for bias and unrepresentativeness in the opportunistic sampling strategy used in the current study may limit the findings' applicability outside of the research area. To minimise potential bias, improve sample representativeness, and guarantee the generalisability of the results, it is advised that future studies employ either homogenous opportunistic sampling or probability sampling procedures (Bornstein *et al*., 2013; Jager *et al*., 2017). Winter samples were collected in August 2021 (during the cold and wet winter period that occurs from April to September), and summer samples in February 2022 (during the hot and dry summer period that occurs from October to March). The feed samples were categorised into 10 different groups, namely bakery wastes, commercial feeds, dairy wastes, forages, fruit wastes, cereal grains and by-products, legume grains, kitchen wastes, homemade mixed diets, and vegetable wastes. Note that some feedstuffs were only available on one farm and/or in one season at the time of collection; thus, the types of samples collected and the number of repetitions were not uniform across seasons.

Depending on the moisture content of the feed, 0.5 kg dry samples and 1.0 kg wet samples were collected in labelled zip-lock plastic bags (Melbro Wholesale Pty Ltd, China). After collection, the feed samples were transported to the Stellenbosch University Department of Animal Science's nutrition laboratory in a cooler box containing ice for chemical analyses. At the laboratory, samples were weighed and dried in an oven at 60 °C to a constant weight. After drying, the samples were milled using a Centrotec® hammer mill (Centurion, South Africa) with a 2 mm sieve for chemical analysis. All the collected feed samples were analysed for proximate parameters and gross energy (GE) content. Mineral and amino acid analyses were performed on selected samples with elevated ash (≥5%) and crude protein (CP, ≥15%) contents. Higher ash and protein concentrations in feeds generally indicate greater total quantities of minerals and amino acids, respectively. This selection strategy was adopted for cost efficiency.

Nutrient profiling

Protocols 934.01, 920.39, and 942.05 of the Association of Official Analytical Chemists (AOAC, 2002) were used to determine the dry matter (DM), ether extract (EE), and ash concentrations, respectively. The LECO® FP 828 (LECO, St. Joseph, MI, USA) nitrogen analyser was used to determine the CP concentration using the Dumas combustion method (992.15). The nitrogen-to-protein conversion factor used was 6.25. The ANKOM^{220} Fibre Analyzer (Ankom Technology Corp., Fairport, NY, USA) was used to determine the crude fibre (CF) concentration, exclusive of residual ash. A compact semi-automated combustion calorimeter (IKA® C200 Oxygen Bomb Calorimeter, CP 00 Bomb Calorimeter, Wilmington, NC, USA) was used to determine the GE content. Each sample was analysed in duplicate.

The mineral composition of the feed samples was assessed using Inductively Coupled Plasma Emission Spectrometry (ICP-AES) following the procedure outlined by Manditsera *et al.* (2019). In brief, 300 mg of ground feed samples were hydrolysed with a solution of concentrated nitric acid (65%) and hydrochloric acid (37%) using a microwave digestor (MARS, 5 High-Pressure System, CEM Corporation), with hydrogen peroxide used to remove nitrous vapours. Macro- (calcium, magnesium, phosphorus, potassium, sulphur, and sodium) and microminerals (aluminium, barium, boron, chromium, copper, iron, nickel, strontium, and zinc) were quantified using the iCAP 6000 series spectrometer (Thermo Fisher Scientific Inc., Waltham, MA, USA). Each sample was analysed in duplicate.

The separation and detection of amino acids was conducted using a Waters ACQUITY Ultra Performance Liquid Chromatograph equipped with a photodiode array detector (UPLC-PDA). Feed samples (100 mg) for amino acid analysis were hydrolysed with 0.5 mL of 6 M hydrochloric acid. The derivatisation process of the amino acids was performed by adding 70 µL of AccQFluor Reagent 1 into 1.5 mL Eppendorf tubes containing 10 µL of the supernatant of the sample or standard (L-Norvaline). The mixture was vortexed for 10 seconds and 20 µL of AccQFluor Reagent 2A (kit WAT052875; En Yvelines Cedex, France) was added. This mixture was vortexed for another 10 seconds before being capped and placed in an oven at 55 °C for 10 minutes to stabilise the derivatives. A 1 µL aliquot of the stabilised sample or standard solution was injected into the mobile phase of the Waters UltraTag C18 column (2.1 m × 50 mm × 1.7 µm) set at 60 °C. As amino acids eluted from the column, their retention times were determined using the photodiode array detector. MassLynx V4.1 2011 software (Waters, Milford, USA) was used to acquire data for calibration curve plotting and the quantification of amino acid concentrations. The final concentrations (% DM) were calculated using peak areas and retention times relative to the standard amino acids. All feed nutrient analyses were performed in duplicate.

Statistical analysis

All data were analysed using SAS v.9.4 (SAS Institute Inc., Cary, NC, USA). The PROC FREQ procedure of SAS was used to generate frequencies of feedstuff availability for the winter and summer seasons. The chi-square test was used to determine the association between feedstuff categories and seasonal availability. Means and standard deviations were generated using the PROC MEANS procedure. Data were further subjected to principal component analysis to generate biplots to visualise relationships between nutrients within the feed groups, and to identify patterns, clusters, and outliers. Note that some feedstuffs were only available on one farm and/or in one season at the time of collection; thus the types of samples and numbers of repetitions were not uniform across seasons, as required for employing analysis of variance.

Results and discussion

Seasonal availability of feedstuffs on small-scale urban pig farms

The current study provides baseline information about the nutrient profiles of feedstuffs available on small-scale urban pig farms in the Cape Metropole area of the Western Cape during both the hot-dry summer and cool-wet winter. The variation in seasonal availability and chemical composition values of the feedstuffs identified in this study is typical. It reflects variations reported elsewhere among small-scale urban pig farmers in developing countries such as Uganda, Kenya, Cambodia, and Congo (Kambashi *et al.*, 2014; Carter *et al.*, 2015a,b; Sol *et al.*, 2016; Sreng *et al.*, 2020).

Figure 1 shows the availability of the different pig feedstuff categories by season. There was an association ($P \leq 0.05$) between seasonal availability and feedstuff category. Fruits were the most frequently available feedstuffs in summer (contributing 35.7% of the total feed types identified), followed by kitchen wastes, bakery by-products, and vegetables, each of which contributed 14.3% of the total feed types identified. In winter, bakery wastes and cereal grains were the most abundant pig feedstuffs (18.5%), followed by kitchen wastes (16.7%). The association of feed categories with season could be attributed to the seasonal variations in sunlight, precipitation, and temperature patterns, which influence plant growth (Nardone *et al.*, 2010; Kassam *et al.*, 2012; Michaletz, 2018). Summer is the growing and harvesting season for most vegetables, berries, melon, pome, citrus, and cactus fruits identified in this study. This may translate to greater spoilage incidences (Alegbeleye *et al.*, 2022) and abundant vegetable and fruit wastes in summer (Cassani & Gomez-Zavaglia, 2022). The higher prevalence of bakery wastes in winter could be linked to the high production of bakery products, increased atmospheric moisture in this season, and water activity within the food matrix (Smith *et al.*, 2004; Masanabo & Chatur, 2023). High atmospheric humidity encourages the proliferation of spoilage microbes, while high water activity results in undesired textural changes (Smith *et al.*, 2004), leading to substantial product losses. In general, the NCFR identified in the current study are preferred by small-scale pig producers over commercial feeds because they are abundantly available, and more accessible and affordable (Mbuthia *et al.*, 2015; Motsa'a *et al.*, 2018). However, the availability of kitchen waste differs from one area to another owing to distinctive variations in the eating habits of the local people (Saikia & Bhar, 2010).

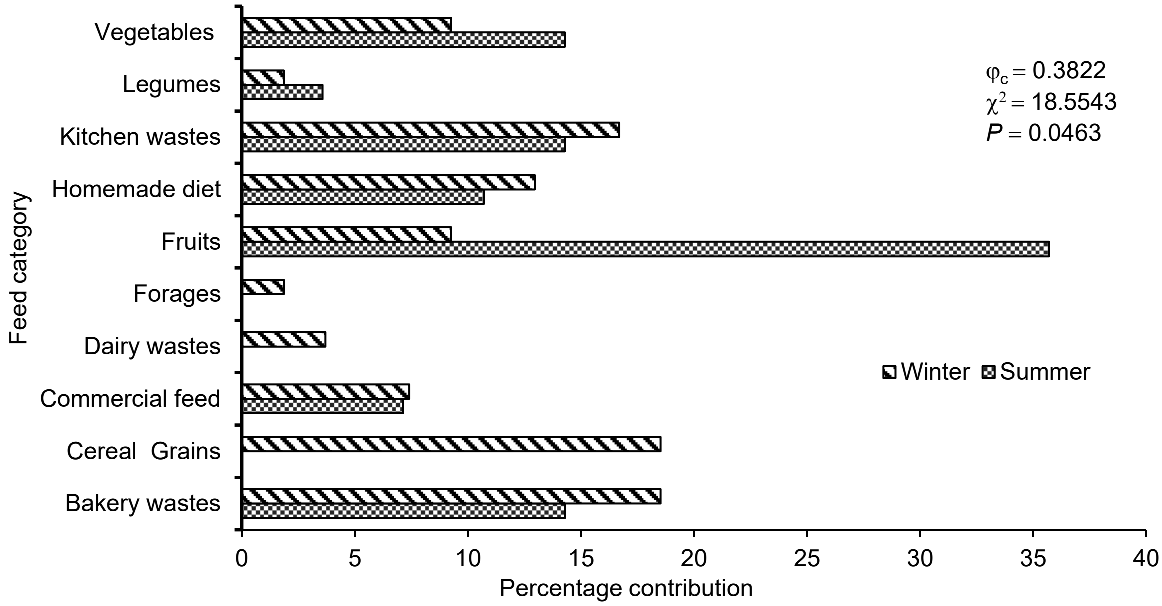

Figure 1 Seasonal availability of locally available pig feedstuffs on small-scale urban farms in the Cape Metropole, South Africa.

The Figure 2 biplot presents the relationships between the samples (e.g. feed groups) and variables (e.g. specific nutrients) sampled in summer. Factor 1 (F1) and factor 2 (F2) collectively explained 81.5% of the total variance. Factor 1 (65.8%) served as the energy/fat axis and was characterised by highly positive loadings from EE, GE, digestible energy (DE), and metabolisable energy (ME), and highly negative loadings from CF and ash. This factor strongly separated the feedstuffs, with those on the positive side being high in fat and GE, and those on the negative side being high in CF and ash components that dilute energy density. Factor 2 (15.7%) indicated the protein versus fibre/ash axis and was defined by highly positive loadings from ash and CF, a highly negative loading from DM, and moderately positive loadings from CP and EE. This axis separated feedstuffs containing high ash and fibre concentrations from those with a high DM content. The summer feed energy variables (EE, GE, DE, and ME) clustered closely together and pointed strongly to the right, confirming that they measure a similar underlying nutrient. Directly opposing them, the CF and ash vectors point to the left and slightly upwards, creating a clear gradient from high-energy, high-fat feeds to high-fibre, high-ash feeds along the F1 axis. Regarding observation grouping, kitchen wastes and some bakery by-products had highly positive F1 scores, identifying them as high-energy feedstuffs, while fruits and some cereal grains had highly negative F1 scores, marking them as high-fibre and lower-energy feedstuffs.

For the winter feed group (Figure 3), F1 and F2 explained 59.4% and 23.5% of the total variance, respectively, totalling 82.8%. Factor 1 served as the energy/fat axis while F2 served as the protein/ash versus fibre axis, following the summer findings. However, a key difference from summer is seen in F2, where the CP vector points strongly upwards in a similar direction to CF and ash, implying that in winter, there are feedstuffs that are simultaneously high in protein, fibre, and ash, potentially representing specific roughages or mixed rations. Regarding observation grouping, vegetables and forages had strongly negative F1 scores, identifying them as low-energy, high-fibre feedstuffs, while some bakery by-products and kitchen wastes had highly positive F1 scores, confirming them as high-energy options. Notably, the dairy by-products were massive outliers, with extremely highly positive F1 scores, marking them as ultra-high-energy winter feeds.

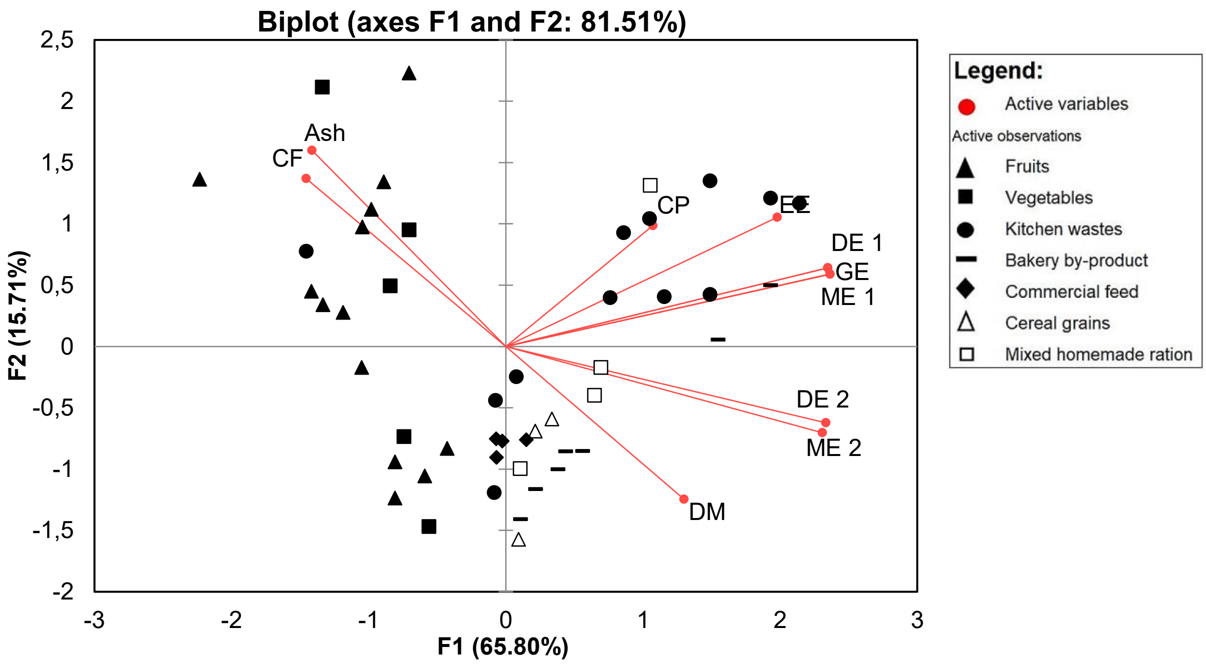

Figure 2 Principal component analysis results for locally available pig feedstuffs sampled during summer in the Cape Metropole, South Africa. F1: factor 1, F2: factor 2, DM: dry matter, CP: crude protein, CF: crude fibre, EE: ether extract, GE: gross energy, DE: digestible energy, ME: metabolisable energy. DE 1 (kcal/kg) = 1.161 + (0.749 × GE) − (4.3 × ash) − (4.1 × CF). DE 2 (kcal/kg) = 4.168 − (9.1 × ash) + (1.9 × CP) + (3.9 × EE) − (3.6 × CF). ME 1 (kcal/kg) = (1 × DE 1) − (0.68 × CP). ME 2 (kcal/kg) = 4.194 − (9.2 × ash) + (1 × CP) + (4.1 × EE) − (3.5 × CF).

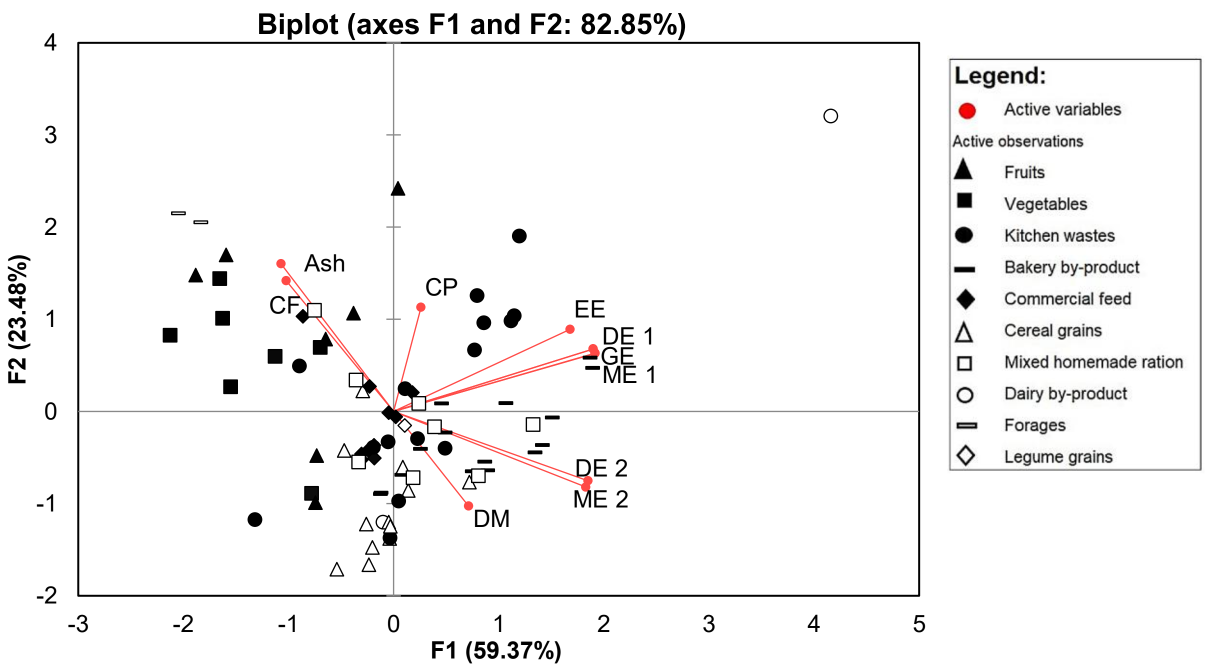

Figure 3 Principal component analysis results for locally available pig feedstuffs during winter in the Cape Metropole, South Africa. F1: factor 1, F2: factor 2, DM: dry matter, CP: crude protein, CF: crude fibre, EE: ether extract, GE: gross energy, DE: digestible energy, ME: metabolisable energy. DE 1 (kcal/kg) = 1.161 + (0.749 × GE) − (4.3 × ash) − (4.1 × CF). DE 2 (kcal/kg) = 4.168 − (9.1 × ash) + (1.9 × CP) + (3.9 × EE) − (3.6 × CF). ME 1 (kcal/kg) = (1 × DE 1) − (0.68 × CP). ME 2 (kcal/kg) = 4.194 − (9.2 × ash) + (1 × CP) + (4.1 × EE) − (3.5 × CF).

Proximate composition of feedstuffs available on small-scale urban pig farms

The proximate and GE profiles of locally available pig feedstuffs sampled in the summer months within the Cape Metropole are presented in Table 1. Commercial feeds, cereal by-products, and legume grains had the highest DM concentrations (87%–91%), followed by bakery wastes (69%–86%). The lowest DM was observed in fruit and vegetable wastes, with DM concentrations ranging from 4% to 25%. Soybean and milk mix, spinach, and Russian sausage had high CP concentrations (31.3%–48.3%). These were followed by grower and weaner pellets, pollard, bun crumbs with legume seeds, soybean meal, kitchen swill, bun and milk mix, cauliflower, and green beans, which had intermediate CP concentrations, ranging from 16% to 23%. Fruits generally had the lowest CP concentrations (2%–15%). The CF concentration was notably high (>10%) for most fruits and vegetables, and low for bakery wastes (<3%). Kitchen wastes containing meat and bakery wastes with legume seeds had the highest EE (16%–34%) and GE (20–24 MJ/kg) values, while fruit and vegetable wastes had the lowest (0.3%–3.0% EE, 15–18 MJ GE/kg), with the exception of squash (9.6% EE, 19 MJ GE/kg). Pineapples and spinach wastes contained the highest ash concentrations (19%–26%), while bakery wastes had the lowest (<4%).

The winter proximate and GE profiles of the locally available pig feedstuffs are summarised in Table 2. Overall, the highest DM concentrations (86%–90%) were observed in commercial feeds, cereals, legumes, and their by-products. Forages and fruit and vegetable wastes had the lowest DM concentrations (5.9%–20.4%). Dry commercial feed, soybean and fishmeal mix, and ice cream and cheese mix contained high concentrations of CP (31%–35%). Starter and weaner pellets, soybean meal, stewed beef, wraps, bun and milk mix, pollard and fishmeal mix, parsley, and cabbage contained moderate CP concentrations (16%–26%), whereas most cereal and bakery products contained little CP (<10%). The CF concentration was high in fruits, vegetables, and forages (10%–24%) and low in cereal grains and bakery wastes (<3.5%). Feedstuffs containing meat or milk and bakery wastes containing legume seeds had high EE (>18%) and GE (>20 MJ/kg) values, while most cereal, vegetable, and fruit wastes had low values (<4% EE, <18 MJ GE/kg), with the exception of gooseberries (14% EE, 20 MJ GE/kg). Ash values were high in fruit and vegetable wastes (8%–20%) and low in cereals.

The high DM concentrations of the commercial feeds and cereal and legume grains and their by-products in both seasons were expected because a low moisture content (<10%) in these products is required to extend their shelf life (Kumar & Kalita, 2017; Parvej *et al.*, 2020). The low DM concentrations of the forage and fruit and vegetable wastes could be ascribed to the high moisture contents of these fresh and unpreserved products (Kumar *et al.*, 2015; Carter *et al.*, 2016; Sreng *et al.*, 2020). Using fresh produce poses a spoilage challenge for small-scale urban pig farmers with small herds, limited storage facilities, and a lack of preservation technologies such as drying or ensiling (Yang *et al.*, 2021; Alegbeleye *et al.*, 2022). The observed DM concentration of the summer bakery waste was lower than that of the bakery meal values reported by Stein *et al.* (2016), although these values were similar in the winter season, and were comparable for soybean meal, wheat bran, and oats.

In summer, the high CP concentrations in the soybean and milk mix, spinach, and Russian sausage waste could be ascribed to the high CP concentrations in the various parent products, namely soybean meal (34%–46% CP), spinach (20% CP), and meat (20%–22%) (Wood, 2017; Cornescu *et al.*, 2021; Drabińska *et al.*, 2021; Waseem *et al.*, 2021). Similarities in the CP concentrations of these feedstuffs offer an opportunity for substitution in diet formulation based on availability and cost. The identified CP-rich feedstuffs could meet or exceed the minimum CP requirements for piglets (20%), growing pigs (16%), and pregnant/lactating pigs (12%) (NRC, 2012; Stein *et al.*, 2016; Wang *et al.*, 2018). However, care should be taken when feeding spinach and cauliflower because of their low DM content and high antinutritional factor content (Drabińska *et al.*, 2021; Issazadeh *et al.*, 2021). Apart from the fruit waste, the rest of the feed categories could meet the minimum CP requirements of pregnant and lactating pigs.

In winter, dry commercial feed, ice cream and cheese mix, soybean and fish meal mix, soybean meal, stewed beef, wraps, and parsley could meet or exceed the CP requirements of piglets (NRC, 2012; Stein *et al.*, 2016; Wang *et al.*, 2018). However, feedstuffs with moderate CP concentrations of 16%–19% could meet the protein requirements of growing pigs and yield satisfactory piglet performance if supplemented with adequate and balanced amino acids (Wang *et al.*, 2018; Rocha *et al.*, 2022). The rest of the feedstuffs containing between 12% and 15% CP could provide adequate protein (12%) for pregnant and lactating sows.

Table 1 Proximate composition (mean ± standard deviation) of locally available pig feedstuffs sampled during summer in the Cape Metropole, South Africa

Feedstuffs	n	Dry matter (DM, %)	Crude protein (% DM)	Crude fibre (% DM)	Ether extract (% DM)	Gross energy (MJ/kg)	Ash (% DM)
Cereal by-products:							
Pollard	2	88.9 ± 3.21	16.1 ± 3.22	6.12 ± 1.24	4.13 ± 0.88	18.7 ± 2.55	3.59 ± 0.24
Bakery wastes:							
Bread	2	77.9 ± 5.90	11.6 ± 4.52	0.18 ± 0.02	1.61 ± 0.03	18.1 ± 2.65	2.57 ± 0.37
Buns	2	69.3 ± 2.67	14.8 ± 0.76	0.29 ± 0.21	3.60 ± 1.74	18.9 ± 0.71	2.48 ± 0.05
Bun crumbs with legume seeds	2	85.4 ± 6.66	18.7 ± 0.54	3.07 ± 0.18	21.8 ± 2.14	22.1 ± 0.82	2.64 ± 0.27
Buns with cheese	2	75.7 ± 4.23	14.3 ± 2.56	0.07 ± 0.01	7.04 ± 1.84	18.9 ± 3.28	3.94 ± 0.98
Buns with chilli	2	69.6 ± 3.12	15.7 ± 2.48	0.12 ±0.01	2.27 ± 0.51	18.9 ± 3.12	2.49 ± 0.93
Commercial feeds:							
Grower pellets	2	89.7 ± 5.22	16.5 ± 2.46	4.97 ± 0.90	3.58 ± 0.27	17.9 ± 3.09	5.20 ± 1.58
Milk whey pellets	2	89.7 ± 2.99	15.2 ± 3.15	4.67 ± 0. 85	3.96 ± 0.99	17.9 ± 2.70	5.82 ± 1.96
Weaner pellets	2	90.0 ± 0.87	17.6 ± 1.37	2.98 ± 0.26	3.90 ± 1.15	18.0 ± 0.34	5.47 ± 0.41
Legume grains:							
Soybean meal	2	88.9 ± 6.34	15.6 ± 3.67	2.24 ± 0.09	8.17 ± 1.82	18.8 ± 2.25	5.86 ± 0.76
Sunflower seeds	2	87.9 ± 5.78	11.7 ± 2.77	2.09 ± 0.20	1.72 ± 0.10	17.9 ± 2.01	1.40 ± 0.02
Kitchen wastes:							
Cabbage + carrot stir-fry	2	7.44 ± 2.312	11.9 ± 1.89	11.4 ± 2.47	1.39 ± 0.21	16.0 ± 3.20	13.8 ± 2.57
Kitchen swill	8	33.4 ± 9.05	15.3 ± 3.45	2.7 ± 0.78	16.1 ± 8.38	20.6 ± 1.51	5.08 ± 1.69
Pie dough + meat mix	2	42.7 ± 4.98	12.1 ± 2.83	3.26 ± 0.96	28.9 ± 3.62	23.9 ± 3.24	3.23 ± 0.58
Russian sausage	2	47.8 ± 3.24	31.3 ± 3.46	2.28 ± 0.56	34.2 ± 3.48	20.7 ± 2.48	8.67 ± 1.74
Yellow fried rice	2	55.9 ± 4.54	6.99 ± 1.85	0.36 ± 0.02	4.61 ± 0.76	17.7 ± 2.32	3.92 ± 0.68
Homemade mixed diets:							
Bun + milk mix	2	36.9 ± 8.89	16.1 ± 0.15	0.21 ± 0.10	7.09 ± 1.06	19.9 ± 0.13	2.95 ± 0.14
Grower mix[1]	2	87.9 ± 6.02	18.5 ± 2.56	2.98 ± 0.48	2.55 ± 0.25	18.1 ± 3.95	3.85 ± 1.20
Soybean + milk mix	2	27.9 ± 2.34	48.3 ± 4.32	2.60 ± 0.64	4.81 ± 0.67	20.9 ± 3.51	5.83 ± 1.76

n: number of feed samples. [1]Grower mix: grower pellets, flour, fishmeal, soybean meal, and pollard mix.

Table 1 (continued)

Feedstuffs	**n**	**Dry matter (DM, %)**	**Crude protein (% DM)**	**Crude fibre (% DM)**	**Ether extract (% DM)**	**Gross energy (MJ/kg)**	**Ash (% DM)**
Fruit wastes:							
Apples	2	14.6 ± 3.12	2.22 ± 0.35	4.89 ± 1.75	1.60 ± 0.02	16.1 ± 2.60	2.90 ± 0.59
Eggplants	2	8.93 ± 2.92	10.3 ± 1.43	14.5 ± 3.78	1.34 ± 0.04	15.9 ± 1.84	9.12 ± 1.49
Green peppers	2	6.63 ± 2.10	14.6 ± 2.45	15.6 ± 2.47	2.36 ± 0.51	17.1 ± 2.54	10.1 ± 1.02
Oranges	2	15.2 ± 3.55	5.99 ± 0.79	6.04 ± 1.74	1.21 ± 0.08	16.2 ± 2.44	3.74 ± 0.27
Pineapples	2	14.8 ± 2.81	2.14 ± 2.54	5.15 ± 1.25	0.97 ± 0.03	15.2 ± 3.56	26.0 ± 3.62
Plums	2	16.4 ± 2.42	4.52 ± 1.56	4.62 ± 1.32	1.87 ± 0.09	17.4 ± 2.45	2.99 ± 0.82
Prickly pears	2	20.4 ± 3.67	4.61 ± 2.23	21.1 ± 4.20	2.57 ± 0.39	16.5 ± 2.85	5.60 ± 0.36
Pumpkins	2	4.93 ± 0.03	9.08 ± 6.06	17.4 ± 1.71	2.27 ± 0.5	16.8 ± 0.94	9.17 ± 1.39
Red figs	2	16.9 ± 3.24	4.12 ± 1.98	11.8 ± 3.72	2.34 ± 0.08	16.4 ± 3.21	6.90 ± 1.22
Squash	2	11.9 ± 2.65	11.4 ± 1.54	28.1 ± 4.24	9.56 ± 2.40	18.9 ± 3.68	9.68 ± 1.88
Tomatoes	2	4.80 ± 1.38	13.9 ± 2.98	17.4 ± 3.25	3.95 ± 0.96	17.8 ± 3.84	10.3 ± 2.55
Watermelons	2	8.72 ± 1.98	9.25 ± 2.3	2.03 ± 0.83	1.56 ± 0.84	16.4 ± 3.48	3.31 ± 0.94
Vegetable wastes:							
Cauliflower	2	7.58 ± 2.41	22.3 ± 2.54	11.3 ± 2.40	2.26 ± 0.35	17.5 ± 3.14	9.77 ± 1.69
Green beans	2	8.43 ± 3.02	19.2 ± 3.20	12.3 ± 1.85	1.32 ± 0.06	16.9 ± 2.86	7.61 ± 2.68
Potatoes	2	14.7 ± 3.17	10.4 ± 1.34	3.27 ± 0.52	0.35 ± 0.04	16.5 ± 3.52	5.61 ± 1.25
Spinach	2	7.70 ± 2.64	33.6 ± 4.21	11.9 ± 2.01	2.65 ± 0.62	16.4 ± 3.65	19.3 ± 2.84
Sweet potatoes	2	25.4 ± 3.66	4.17 ± 1.32	1.32 ± 0.45	0.63 ± 0.09	16.5 ± 3.24	2.47 ± 0.48

n: number of feed samples.

Table 2 Proximate composition (mean ± standard deviation) of locally available pig feedstuffs sampled during winter in the Cape Metropole, South Africa

Feedstuffs	n	Dry matter (DM, %)	Crude protein (% DM)	Crude fibre (% DM)	Ether extract (% DM)	Gross energy (MJ/kg)	Ash (% DM)
Cereal crop wastes:							
Gold powder[1]	2	86.0 ± 3.21	7.33 ± 1.89	1.99 ± 0.56	2.40 ± 0.36	16.9 ± 2.00	1.74 ± 0.51
Pollard	2	89.3 ± 4.74	9.26 ± 2.58	12.9 ± 2.09	1.54 ± 0.04	16.9 ± 2.30	2.27 ± 0.24
Wheat bran	2	88.3 ± 5.23	13.4 ± 2.42	11.2 ± 2.11	3.56 ± 0.60	17.8 ± 2.30	6.11 ± 0.59
Bakery wastes:							
Bread	2	59.9 ± 1.62	10.6 ± 0.35	0.39 ± 0.18	0.50 ± 0.02	17.2 ± 0.04	2.76 ± 0.07
Biscuits and rusks	2	87.7 ± 4.27	5.76 ± 0.13	0.42 ± 0.04	19.0 ± 2.20	20.5 ± 2.47	2.53 ± 0.31
Cake (brown Swiss roll)	2	77.9 ± 4.51	5.20 ± 0.41	0.82 ± 0.01	18.8 ± 2.34	20.2 ± 2.95	1.73 ± 0.02
Cake (red velvet)	2	81.6 ± 2.49	6.37 ± 0.84	0.92 ± 0.09	10.6 ± 0.96	19.1 ± 2.36	2.36 ± 0.05
Dough	5	62.6 ± 10.9	8.45 ± 2.02	3.23 ± 3.40	19.2 ± 8.51	20.3 ± 1.60	2.40 ± 1.09
Doughnuts	2	70.2 ± 4.18	7.22 ± 0.64	0.47 ± 0.01	12.3 ± 1.27	19.3 ± 2.48	2.27 ± 0.07
Pizza bread	2	61.2 ± 3.99	12.1 ± 2.03	2.12 ± 0.55	13.9 ± 1.23	20.1 ± 3.44	3.52 ± 0.45
Pizza dough	2	54.3 ± 4.33	9.87 ± 1.24	0.92 ± 0.06	19.6 ± 2.11	18.3 ± 3.25	8.23 ± 0.88
Roti	2	70.5 ± 4.36	9.09 ± 2.46	0.45 ± 0.04	5.36 ± 0.68	17.7 ± 2.21	4.33 ± 0.64
Roti dough	2	35.4 ± 3.57	7.96 ± 1.78	0.58 ± 0.08	9.48 ± 1.05	18.9 ± 2.36	4.00 ± 0.93
Commercial feeds:							
Grower pellets	6	87.6 ± 4.22	14.4 ± 4.02	6.67 ± 7.32	3.60 ± 1.58	17.4 ± 0.39	6.29 ± 1.54
Milk whey pellets	2	88.9 ± 4.58	14.4 ± 2.01	2.93 ± 0.74	3.57 ± 0.83	16.9 ± 2.84	6.05 ± 0.77
Wet commercial feed	2	23.9 ± 2.30	13.8 ± 2.56	8.12 ± 1.23	3.85 ± 0.58	17.8 ± 2.09	4.71 ± 0.64
Dry commercial feed	2	89.4 ± 5.22	34.7 ± 3.45	0.06 ± 0.00	2.29 ± 0.48	18.0 ± 2.58	7.24 ± 0.88
Starter pellets	2	87.7 ± 4.85	18.1 ± 3.25	2.61 ± 0.64	2.60 ± 0.95	17.1 ± 2.01	5.94 ± 0.62
Weaner pellets	2	88.3 ± 5.23	17.4 ± 2.10	8.00 ± 1.68	6.49 ± 2.01	17.7 ± 2.32	5.16 ± 0.84
Cereal grains:							
Malt	2	89.1 ± 5.24	7.95 ± 1.48	0.65 ± 0.02	2.65 ± 0.79	16.4 ± 2.10	1.43 ± 0.27
Millet	2	89.6 ± 4.28	8.49 ± 1.02	2.08 ± 0.65	2.82 ± 0.81	17.0 ± 2.41	1.50 ± 0.05
Mixed maize grains	2	86.6 ± 4.55	8.41 ± 075	3.42 ± 0.36	4.72 ± 1.26	17.8 ± 2.90	2.04 ± 0.24

n: number of feed samples. [1]Gold powder is a homogenised and pasteurised feed supplement containing live micro-organisms for direct feeding of pigs.

Table 2 (continued)

Feedstuffs	n	Dry matter (DM, %)	Crude protein (% DM)	Crude fibre (% DM)	Ether extract (% DM)	Gross energy (MJ/kg)	Ash (% DM)
Cereal grains (continued):							
Oats	2	90.9 ± 5.86	13.2 ± 1.03	0.03 ± 0.00	9.14 ± 1.02	18.7 ± 2.47	1.78 ± 0.03
Samp	2	42.1 ± 2.56	4.92 ± 0.95	0.42 ± 0.02	0.69 ± 0.04	16.7 ± 1.98	1.21 ± 0.02
Starch powder	2	43.9 ± 3.66	0.19 ± 0.12	0.20 ± 0.01	0.50 ± 0.04	15.7 ± 3.01	0.34 ± 0.09
White maize	2	86.1 ± 5.24	5.46 ± 1.24	0.25 ± 0.03	0.65 ± 0.05	16.4 ± 2.30	0.46 ± 0.01
Yellow maize (dry)	3	86.0 ± 1.58	6.60 ± 0.53	0.90 ± 0.17	3.20 ± 0.12	17.6 ± 0.06	1.33 ± 0.23
Yellow maize (fresh)	2	34.4 ± 4.22	7.99 ± 0.83	2.53 ± 0.65	5.97 ± 2.02	17.7 ± 2.66	2.14 ± 0.02
Legume grains:							
Soybean meal	2	90.6 ± 5.23	20.8 ± 3.87	0.79 ± 0.01	6.91 ± 0.23	17.8 ± 2.56	7.29 ± 1.23
Kitchen wastes:							
Carrots + sauce	5	10.8 ± 1.83	12.3 ± 2.55	5.48 ± 0.04	8.93 ± 1.08	18.2 ± 3.54	4.53 ± 0.82
Carrots + soup	2	19.6 ± 2.49	1.42 ± 0.08	1.78 ± 0.01	1.16 ± 0.15	14.3 ± 2.11	5.79 ± 2.10
Kitchen swill	2	24.2 ± 3.81	14.9 ± 4.00	3.91 ± 1.17	16.4 ± 6.06	19.7 ± 1.25	6.01 ± 1.45
Macaroni + spaghetti	2	48.0 ± 4.62	12.9 ± 2.45	0.07 ± 0.00	0.73 ± 0.02	17.4 ± 3.10	0.73 ± 0.22
Potato chips + rolls	2	40.2 ± 4.23	14.1 ± 2.46	0.20 ± 0.01	7.91 ± 1.04	18.5 ± 2.69	2.49 ± 0.33
Spaghetti + vegetables	2	23.7 ± 2.56	13.4 ± 2.20	1.04 ± 0.01	6.23 ± 0.22	18.1 ± 2.41	3.10 ± 0.23
Stewed beef	2	21.5 ± 3.24	24.8 ± 2.36	11.0 ± 2.09	19.9 ± 2.33	21.4 ± 3.28	6.87 ± 1.99
Vegetable stir-fry	2	7.52 ± 1.30	12.3 ± 2.34	8.98 ± 3.44	1.76 ± 0.03	16.6 ± 2.32	8.22 ± 2.98
Wraps	2	41.7 ± 4.23	25.9 ± 2.78	1.64 ± 5.21	12.1 ± 0.22	20.3 ± 3.25	9.79 ± 1.99
Homemade mixed diets:							
Bread + vegetables	2	26.6 ± 3.88	13.2 ± 2.45	2.17 ± 0.53	2.96 ± 0.72	17.7 ± 2.31	9.17 ± 1.04
Bun + milk mix	2	30.5 ± 2.33	16.4 ± 2.68	0.06 ± 0.00	5.32 ± 059	18.6 ± 3.62	3.43 ± 0.65
Chocolate + bran mix	2	79.2 ± 4.21	8.53 ± 1.42	1.28 ± 0.04	12.5 ± 2.14	18.9 ± 3.48	1.51 ± 0.36
Dough + kitchen waste mix	2	50.1 ± 3.55	15.1 ± 2.51	0.31 ± 0.01	3.24 ± 0.48	17.7 ± 2.87	1.70 ± 0.03
Doughnuts with grains	2	73.8 ± 4.22	7.04 ± 1.78	1.67 ± 0.07	19.5 ± 2.24	20.4 ± 2.41	2.97 ± 0.49
Soybean + fish meal mix	2	89.3 ± 5.77	32.9 ± 3.65	0.26 ± 0.01	1.49 ± 0.06	18.2 ± 3.11	6.14 ± 0.95

n: number of feed samples.

Table 2 (continued)

Feedstuffs	n	Dry matter (DM, %)	Crude protein (% DM)	Crude fibre (% DM)	Ether extract (% DM)	Gross energy (MJ/kg)	Ash (% DM)
Homemade mixed diets (continued):							
Maize meal + bread flour mix	2	84.7 ± 5.20	12.5 ± 2.12	5.09 ± 1.63	4.12 ± 0.64	16.8 ± 2.01	4.96 ± 0.22
Wheat pollard + fishmeal mix	2	81.9 ± 4.36	18.6 ± 2.08	14.2 ± 2.46	3.91 ± 0.87	17.5 ± 2.34	11.5 ± 1.64
Dairy wastes:							
Ice cream + cheese mix	2	49.1 ±4.28	31.3 ± 4.20	4.08 ± 1.32	49.0 ± 4.25	27.6 ± 3.27	8.11 ± 1.08
Forages:							
Parsley	2	10.1 ± 2.25	26.3 ± 5.51	15.4 ± 0.51	4.22 ± 0.90	15.2 ± 0.05	19.2 ± 2.35
Fruit wastes:							
Apples	2	15.3 ± 2.12	1.32 ± 0.02	4.76 ± 1.05	2.29 ± 0.05	15.8 ± 3.21	2.20 ± 0.46
Butternut	2	12.8 ± 2.45	12.8 ± 2.56	12.4 ± 2.78	6.50 ± 1.00	17.2 ± 1.87	7.75 ±1.96
Gooseberries	2	19.9 ± 2.79	10.6 ± 1.50	16.9 ± 2.85	14.0 ± 2.30	20.4 ± 2.56	13.4 ± 2.62
Oranges	2	15.2 ± 2.10	5.45 ± 1.03	7.00 ± 1.68	2.04 ± 0.07	16.2 ± 1.95	3.56 ± 0.84
Red pepper	2	9.53 ± 1.24	10.7 ± 1.95	13.3 ± 2.36	6.70 ± 1.02	18.3 ± 3.47	7.65 ± 2.84
Tomatoes	2	5.87 ± 0.75	14.1 ± 1.97	13.0 ± 2.62	3.73 ± 0.49	16.2 ± 3.01	17.2 ± 2.45
Watermelon	2	6.94 ± 0.69	6.12 ± 1.54	23.7 ± 3.24	3.79 ± 0.54	15.5 ± 2.48	12.4 ± 3.58
Vegetable wastes:							
Cabbage	2	9.27 ± 2.84	16.8 ± 1.61	15.6 ± 0.54	2.83 ± 0.69	15.4 ± 0.21	12.9 ± 2.37
Carrots	2	8.16 ± 0.73	5.76 ± 0.60	9.15 ± 1.10	1.86 ± 0.36	14.8 ± 0.49	14.2 ± 4.10
Greek salad	2	5.48 ± 1.36	14.5 ± 3.21	11.2 ± 2.30	3.82 ± 0.85	17.1 ± 2.36	7.21 ± 1.40
Onions	2	9.95 ± 2.14	12.8 ± 2.10	10.4 ± 1.48	2.02 ± 0.84	16.2 ± 2.14	9.44 ± 2.35
Potatoes	2	20.4 ± 3.12	7.75 ± 1.85	0.91 ± 0.02	0.41 ± 0.02	15.7 ± 2.48	4.40 ± 1.85

n: number of feed samples.

Regardless of the season, feedstuffs containing more than 10% CF (forages, fruits, and vegetables) should be utilised with care, as they may compromise pig feed intake, gut health, growth performance, carcass yield, and, ultimately, economic returns (Axelsson & Eriksson, 1953; Millet *et al.*, 2010; Bee *et al.*, 2021). For sows, high-fibre diets may reduce energy intake, decrease weight gain, and lower piglets' birthweights (Etienne, 1987). The majority of the feedstuffs sampled in both summer and winter, especially the kitchen wastes containing meat, dairy wastes, and bakery wastes containing legume seeds, contained more than 15 MJ GE/kg DM, and could thus meet the minimum DE requirements (15 MJ/kg DM) of growing pigs (NRC, 2012; Stein *et al.*, 2016). However, care must be taken when utilising feedstuffs with EE concentrations >12%, as they may result in a drastic decline in feed intake and reduced animal performance and meat quality (Liu *et al.*, 2018; Wealleans *et al.*, 2021; Vastolo *et al.*, 2022). While GE may not be a good indicator of available dietary energy, it can provide a rough estimate of available DE (Noblet & Le Goff, 2001; Giromini *et al.*, 2017).

Amino acid composition (% DM) of selected feedstuffs available on small-scale urban pig farms

Leucine was the most abundant essential amino acid, while methionine was the most limiting essential amino acid in all the feedstuffs (Table 3a). The soybean and milk mix contained the highest concentrations of essential amino acids: histidine (0.74%), arginine (2.39%), threonine (1.59%), lysine (2.06%), methionine (0.43%), valine (2.25%), isoleucine (2.31%), leucine (3.63%), and phenylalanine (2.27%). The lowest concentrations of essential amino acids were observed in buns (0.16% arginine, 0.39% threonine, 0.16% lysine, 0.63% valine, 0.58% isoleucine, and 1.08% leucine, Table 3a). The soybean and milk mix also had the highest concentrations of all the non-essential amino acids (tyrosine, serine, glycine, aspartic acid, glutamine, alanine, and proline) (Table 3b). The non-essential amino acids were present at the lowest concentrations in green beans (0.05% tyrosine, 0.79% proline), wheat pollard (0.62% serine), buns with chilli (0.6% glycine), buns (0.61% aspartic acid, 0.46% alanine), and cauliflower (2.17% glutamine) (Table 3b).

Leucine and methionine were the most abundant and limiting essential amino acids, respectively, for all feedstuffs sampled in winter (Table 4a). Dry commercial feed had the highest concentration of essential amino acids, including histidine (0.79%), arginine (1.96%), threonine (1.37%), and lysine (2.27%), while methionine (0.92%), valine (1.98%), isoleucine (1.65%), leucine (3.05%), and phenylalanine (1.80%) were present at the highest concentrations in the ice cream and cheese mix (Table 4a). Most of the essential amino acids were found at the lowest concentrations in the dough and kitchen waste mixed feed, with the exception of lysine, methionine, isoleucine, and leucine, which were lowest in the bun and milk mix (0.37%), parsley (0.22%), and cabbage (0.63%, 1.1%), respectively (Table 4a). Similarly, dry commercial feed had the highest concentration of non-essential amino acids, including tyrosine (1.25%), glycine (1.85%), aspartic acid (3.33%), and alanine (2.12%), while the ice cream and cheese mix had the highest serine (1.69%), glutamine (6.65%), and proline (3.56) concentrations (Table 4b). Cabbage contained the lowest concentrations of serine (0.59%), aspartic acid (1.37%), glutamine (2.03%), and proline (0.78%), while the dough and kitchen waste mix had the lowest tyrosine (0.38%) and glycine (0.55%) concentrations (Table 4b).

Lysine, methionine, and threonine are the three primary first-limiting amino acids required for nursing, fattening, pregnant, and lactating pigs, in order (NRC, 2012). Only the Russian sausage waste, soybean and milk mix, dry commercial feed, ice cream and cheese mix, wrap waste, and soybean and fish meal mix could meet the lysine, methionine, and threonine requirements of piglets. Bakery waste sampled in the summer showed similar values for lysine, methionine, and threonine as reported by Stein *et al.* (2016) for bakery meals, and could be incorporated into pig diets if variations in the product composition of bakery feedstuffs and lysine levels are considered. Irrespective of the season, spinach, starter pellets, and soybean meal could meet growing pigs' lysine, methionine, and threonine requirements. For soybean meal, lower comparable values for amino acids were reported by Stein *et al.* (2016), and this variation could be attributed to the source and origin of the soybeans and the manufacturing process used. The use of soybean meal in both seasons can be associated with its availability and the farmers' knowledge of its importance in pig diets (Sreng *et al.*, 2020). Grower pellets, weaner pellets, grower mix, kitchen swill, stewed beef, and wheat pollard and fishmeal mix could meet the gestation and lactation requirements of sows for lysine, methionine, and threonine. Feedstuffs containing lower concentrations of the first-limiting amino acids should be fed with feedstuffs rich in these amino acids or supplemented with synthetic sources to meet pigs' daily nutritional requirements (Wang *et al.*, 2018; Wellington *et al.*, 2023).

Table 3a Essential amino acid composition (mean ± standard deviation, on a percentage dry matter basis) of locally available pig feedstuffs sampled during summer in the Cape Metropole, South Africa

Feedstuffs	n	His	Arg	Thr	Lys	Met	Val	Ile	Leu	Phe
Cereal by-products:										
Wheat pollard	2	0.25 ± 0.11	0.88 ± 0.03	0.45 ± 0.01	0.47 ± 0.01	0.18 ± 0.00	0.68 ± 0.02	0.51 ± 0.00	0.95 ± 0.01	0.55 ± 0.01
Commercial feeds:										
Grower pellets	2	0.12 ± 0.01	0.97 ± 0.03	0.61 ± 0.02	0.97 ± 0.02	0.29 ± 0.00	0.77 ± 0.03	0.69 ± 0.01	1.31 ± 0.01	0.69 ± 0.01
Milk whey pellets	2	0.36 ± 0.08	1.12 ± 0.06	0.58 ± 0.01	0.59 ± 0.01	0.30 ± 0.00	0.73 ± 0.02	0.62 ± 0.01	1.33 ± 0.02	0.78 ± 0.02
Weaner pellets	2	0.23 ± 0.04	0.96 ± 0.15	0.68 ± 0.11	0.95 ± 0.07	0.31 ± 0.06	0.79 ± 0.05	0.70 ± 0.05	1.39 ± 0.14	0.66 ± 0.09
Legume grains:										
Soybean meal	2	0.30 ± 0.02	0.99 ± 0.05	0.53 ± 0.01	0.46 ± 0.01	0.26 ± 0.00	0.72 ± 0.02	0.60 ± 0.01	1.25 ± 0.02	0.76 ± 0.02
Bakery wastes:										
Buns	2	0.27 ± 0.01	0.61 ± 0.02	0.39 ± 0.00	0.16 ± 0.00	0.26 ± 0.00	0.63 ± 0.01	0.58 ± 0.00	1.08 ± 0.02	0.71 ± 0.02
Buns with chilli	2	0.26 ± 0.01	0.54 ± 0.01	0.40 ± 0.01	0.12 ± 0.00	0.19 ± 0.00	0.68 ± 0.02	0.59 ± 0.01	1.09 ± 0.02	0.76 ± 0.02
Bun crumbs with legume seeds	2	0.31 ± 0.03	1.48 ± 0.08	0.56 ± 0.00	0.27 ± 0.04	0.34 ± 0.01	0.80 ± 0.01	0.69 ± 0.01	1.30 ± 0.02	0.94 ± 0.02
Kitchen wastes:										
Kitchen swill	4	0.32 ± 0.06	0.79 ± 0.14	0.56 ± 0.09	0.70 ± 0.16	0.30 ± 0.05	0.81 ± 0.11	0.72 ± 0.13	1.26 ± 0.17	0.69 ± 0.10
Russian sausage	2	0.47 ± 0.03	1.51 ± 0.12	0.90 ± 0.02	1.83 ± 0.10	0.52 ± 0.02	1.11 ± 0.06	0.99 ± 0.01	1.78 ± 0.04	0.85 ± 0.02
Homemade mixed diets:										
Bun + milk mix	2	0.22 ± 0.04	0.55 ± 0.03	0.46 ± 0.01	0.19 ± 0.09	0.26 ± 0.00	0.69 ± 0.05	0.58 ± 0.08	1.13 ± 0.01	0.76 ± 0.05
Grower mix[1]	2	0.38 ± 0.01	1.04 ± 0.05	0.64 ± 0.2	0.84 ± 0.01	0.27 ± 0.00	0.86 ± 0.01	0.76 ± 0.01	1.38 ± 0.01	0.80 ± 0.02
Soybean + milk mix	2	0.74 ± 0.04	2.39 ± 0.12	1.59 ± 0.06	2.06 ± 0.06	0.53 ± 0.01	2.25 ± 0.09	2.31 ± 0.12	3.63 ± 0.08	2.27 ± 0.05
Vegetables:										
Cauliflower	2	0.28 ± 0.01	0.84 ± 0.01	0.63 ± 0.02	0.37 ± 0.00	0.26 ± 0.00	1.00 ± 0.04	0.81 ± 0.01	1.19 ± 0.03	0.88 ± 0.01
Green beans	2	0.23 ± 0.01	0.68 ± 0.01	0.58 ± 0.01	0.50 ± 0.01	0.18 ± 0.00	0.87 ± 0.01	0.77 ± 0.02	1.09 ± 0.02	0.59 ± 0.00
Spinach	2	0.41 ± 0.02	1.81 ± 0.06	1.18 ± 0.08	1.26 ± 0.05	0.32 ± 0.01	1.65 ± 0.08	1.35 ± 0.05	2.30 ± 0.03	1.40 ± 0.01

n: number of feed samples. [1]Grower mix: grower pellets, flour, fishmeal, soybean meal, and pollard mix. His: histidine, Arg: arginine, Thr: threonine, Lys: lysine, Met: methionine, Val: valine, Ile: isoleucine, Leu: leucine, Phe: phenylalanine.

Table 3b Non-essential amino acid composition (mean ± standard deviation, on a percentage dry matter basis) of locally available pig feedstuffs sampled during summer in the Cape Metropole, South Africa

Feedstuffs	n	Tyr	Ser	Gly	Asp	Glu	Ala	Pro
Cereal by-products:								
Wheat pollard	2	0.96 ± 0.01	0.62 ± 0.01	0.76 ± 0.02	0.94 ± 0.03	3.24 ± 0.18	0.63 ± 0.02	1.21 ± 0.04
Commercial feeds:								
Grower pellets	2	0.52 ± 0.01	0.72 ± 0.02	0.71 ± 0.02	1.63 ± 0.05	3.28 ± 0.18	0.82 ± 0.03	1.08 ± 0.03
Milk whey pellets	2	0.56 ± 0.01	0.68 ± 0.02	0.75 ± 0.02	1.26 ± 0.16	2.68 ± 0.01	0.76 ± 0.02	1.08 ± 0.03
Weaner pellets	2	0.48 ± 0.09	0.73 ± 0.05	0.73 ± 0.06	1.53 ± 0.24	3.07 ± 0.19	0.83 ± 0.02	1.11 ± 0.03
Legume grains:								
Soybean meal	2	0.59 ± 0.02	0.67 ± 0.02	0.73 ± 0.1	1.40 ± 0.12	2.81 ± 0.23	0.70 ± 0.02	1.06 ± 0.04
Bakery wastes:								
Buns	2	0.46 ± 0.01	0.71 ± 0.02	0.62 ± 0.01	0.61 ± 0.02	5.05 ± 0.60	0.46 ± 0.01	1.77 ± 0.06
Buns with chilli	2	0.49 ± 0.01	0.70 ± 0.02	0.60 ± 0.01	0.63 ± 0.02	5.03 ± 0.56	0.48 ± 0.01	1.85 ± 0.08
Bun crumbs with legume seeds	2	0.79 ± 0.01	0.80 ± 0.02	0.87 ± 0.02	1.11 ± 0.09	4.80 ± 0.15	0.73 ± 0.01	1.58 ± 0.02
Kitchen wastes:								
Kitchen swill	4	0.60 ± 0.10	0.72 ± 0.02	0.67 ± 0.15	1.14 ± 0.21	3.73 ± 0.20	0.76 ± 0.18	1.40 ± 0.11
Russian sausage	2	0.85 ± 0.03	0.84 ± 0.02	1.69 ± 0.04	2.21 ± 0.15	3.59 ± 0.60	1.53 ± 0.05	1.53 ± 0.05
Homemade mixed diets:								
Bun + milk mix	2	0.54 ± 0.07	0.70 ± 0.04	0.61 ± 0.03	0.65 ± 0.10	4.96 ± 0.17	0.57 ± 0.06	1.86 ± 0.05
Grower mix[1]	2	0.04 ± 0.03	0.80 ± 0.04	0.87 ± 0.02	1.53 ± 0.11	3.78 ± 0.18	0.89 ± 0.02	1.38 ± 0.04
Soybean + milk mix	2	1.88 ± 0.08	2.06 ± 0.09	1.70 ± 0.03	4.53 ± 0.23	7.91 ± 0.98	1.84 ± 0.04	3.23 ± 0.12
Vegetables:								
Cauliflower	2	0.65 ± 0.02	0.69 ± 0.02	0.81 ± 0.02	1.75 ± 0.10	2.17 ± 0.10	0.93 ± 0.02	0.91 ± 0.02
Green beans	2	0.05 ± 0.00	0.79 ± 0.02	0.66 ± 0.01	2.10 ± 0.09	1.31 ± 0.08	0.91 ± 0.02	0.79 ± 0.02
Spinach	2	1.21 ± 0.08	1.07 ± 0.03	1.61 ± 0.03	2.70 ± 0.09	4.02 ± 0.13	1.54 ± 0.08	1.43 ± 0.10

n: number of feed samples. [1]Grower mix: grower pellets, flour, fishmeal, soybean meal, and pollard mix. Ser: serine, Gly: glycine, Asp: aspartic acid, Glu: glutamine, Ala: alanine, Pro: proline, Tyr: tyrosine.

Table 4a Essential amino acid composition (mean ± standard deviation, on a percentage dry matter basis) of locally available pig feedstuffs sampled during winter in the Cape Metropole, South Africa

Feedstuffs	n	His	Arg	Thr	Lys	Met	Val	Ile	Leu	Phe
Commercial feeds:										
Grower pellets	5	0.32 ± 0.07	0.96 ± 0.11	0.63 ± 0.05	1.02 ± 0.15	0.28 ± 0.02	0.76 ± 0.04	0.64 ± 0.06	1.32 ± 0.09	0.65 ± 0.13
Dry commercial feed	2	0.79 ± 0.07	1.96 ± 0.12	1.37 ± 0.10	2.27 ± 0.15	0.70 ± 0.03	1.58 ± 0.08	1.37 ± 0.09	2.71 ± 0.10	1.62 ± 0.12
Starter pellets	2	0.32 ± 0.03	1.08 ± 0.12	0.72 ± 0.05	1.28 ± 0.11	0.36 ± 0.02	0.84 ± 0.04	0.74 ± 0.06	1.38 ± 0.09	0.71 ± 0.13
Weaner pellets	2	0.35 ± 0.03	1.12 ± 0.14	0.70 ± 0.05	0.97 ± 0.08	0.37 ± 0.02	0.78 ± 0.04	0.71 ± 0.06	1.49 ± 0.09	0.79 ± 0.15
Legume grains:										
Soybean meal	2	0.44 ± 0.03	1.37 ± 0.12	0.74 ± 0.05	1.48 ± 0.14	0.33 ± 0.02	0.97 ± 0.07	0.92 ± 0.08	1.65 ± 0.10	0.79 ± 0.15
Dairy products:										
Ice cream + cheese mix	2	0.65 ± 0.04	1.13 ± 0.10	1.16 ± 0.11	1.87 ± 0.15	0.92 ± 0.06	1.98 ± 0.09	1.65 ± 0.10	3.05 ± 0.15	1.80 ± 0.23
Kitchen wastes:										
Kitchen swill	2	0.38 ± 0.14	0.96 ± 0.39	0.69 ± 0.04	0.97 ± 0.40	0.30 ± 0.17	0.92 ± 0.29	0.81 ± 0.60	1.45 ± 0.48	0.78 ± 0.25
Stewed beef	2	0.62 ± 015	1.30 ± 0.21	0.78 ± 0.06	1.03 ± 0.12	0.38 ± 0.02	1.01 ± 0.07	0.87 ± 0.06	1.50 ± 0.10	0.96 ± 0.41
Wraps	2	0.64 ± 0.16	1.35 ± 0.30	0.97 ± 0.05	1.69 ± 0.09	0.48 ± 0.02	1.20 ± 0.09	1.13 ± 0.08	1.94 ± 0.12	0.93 ± 0.40
Homemade mixed diets:										
Bun + milk mix	2	0.29 ± 0.01	0.58 ± 0.05	0.48 ± 0.005	0.37 ± 0.02	0.28 ± 0.01	0.80 ± 0.04	0.68 ± 0.06	1.28 ± 0.08	0.89 ± 0.36
Dough + kitchen waste mix	2	0.23 ± 0.01	0.60 ± 0.08	0.47 ± 0.05	0.47 ± 0.02	0.32 ± 0.02	0.78 ± 0.04	0.67 ± 0.06	1.18 ± 0.08	0.60 ± 0.31
Soybean + fish meal mix	2	0.67 ± 0.012	1.87 ± 0.13	1.24 ± 0.09	1.73 ± 0.09	0.60 ± 0.02	1.52 ± 0.10	1.37 ± 0.09	2.63 ± 012	1.41 ± 0.35
Wheat pollard + fishmeal mix	2	0.39 ± 0.02	0.92 ± 0.12	0.70 ± 0.05	1.01 ± 0.05	0.37 ± 0.02	0.82 ± 0.04	0.66 ± 0.06	1.28 ± 0.10	0.69 ± 0.30
Forages:										
Parsley	2	0.30 ± 0.07	0.85 ± 0.21	0.85 ± 0.12	0.78 ± 0.13	0.22 ± 0.01	1.18 ± 0.25	0.89 ± 0.21	1.34 ± 0.52	0.93 ± 0.25
Vegetables:										
Cabbage	2	0.27 ± 0.10	0.70 ± 0.30	0.58 ± 0.22	0.60 ± 0.14	0.20 ± 0.04	0.82 ± 0.26	0.63 ± 0.26	1.10 ± 0.53	0.69 ± 0.34

n: number of feed samples. His: histidine, Arg: arginine, Thr: threonine, Lys: lysine, Met: methionine, Val: valine, Ile: isoleucine, Leu: leucine, Phe: phenylalanine.

Table 4b Non-essential amino acid composition (mean ± standard deviation, on a percentage dry matter basis) of locally available pig feedstuffs sampled during winter in the Cape Metropole, South Africa

Feedstuffs	n	Tyr	Ser	Gly	Asp	Glu	Ala	Pro
Commercial feeds:								
Grower pellets	5	0.45 ± 0.09	0.73 ± 0.06	0.71 ± 0.07	1.42 ± 0.09	3.03 ± 0.16	0.82 ± 0.04	1.11 ± 0.08
Dry commercial feed	2	1.25 ± 0.12	1.49 ± 0.08	1.85 ± 0.10	3.33 ± 0.20	5.03 ± 0.20	2.12 ± 0.16	1.82 ± 0.10
Starter pellets	2	0.46 ± 0.02	0.86 ± 0.05	0.79 ± 0.08	1.65 ± 0.16	3.75 ± 0.18	0.83 ± 0.05	1.29 ± 0.16
Weaner pellets	2	0.60 ± 0.02	0.80 ± 0.05	0.76 ± 0.08	1.54 ± 0.15	2.95 ± 010	0.88 ± 0.05	1.17 ± 0.16
Legume grains:								
Soybean meal	2	0.65 ± 0.02	0.97 ± 0.06	0.86 ± 0.09	2.25 ± 019	4.03 ± 0.18	0.98 ± 0.06	1.26 ± 0.18
Dairy products:								
Ice cream + cheese mix	2	2.55 ± 0.13	1.69 ± 0.08	0.74 ± 0.07	2.22 ± 0.20	6.65 ± 0.22	1.18 ± 0.08	3.56 ± 0.20
Kitchen wastes:								
Kitchen swill	2	0.65 ± 0.30	0.82 ± 0.19	0.86 ± 0.36	1.62 ± 0.34	3.79 ± 0.80	0.99 ± 0.28	1.25 ± 0.35
Stewed beef	2	0.04 ± 0.00	0.74 ± 0.06	1.85 ± 0.09	1.96 ± 0.35	3.44 ± 0.56	1.37 ± 0.23	1.53 ± 0.40
Wraps	2	0.80 ± 0.03	0.99 ± 0.08	1.03 ± 0.08	1.86 ± 0.38	4.70 ± 0.32	1.29 ± 0.25	1.49 ± 0.51
Homemade mixed diets:								
Bun + milk mix	2	0.56 ± 0.02	0.76 ± 0.06	0.59 ± 0.06	0.81 ± 0.36	4.83 ± 0.44	0.56 ± 0.10	2.02 ± 0.80
Dough + kitchen waste mix	2	0.38 ± 0.01	0.78 ± 0.06	0.55 ± 0.06	0.90 ± 0.38	4.62 ± 0.52	0.64 ± 0.12	1.62 ± 0.42
Soybean + fish meal mix	2	0.96 ± 0.04	1.38 ± 0.09	1.62 ± 0.09	2.96 ± 0.50	4.77 ± 0.44	1.78 ± 0.14	1.67 ± 0.44
Wheat pollard + fishmeal mix	2	0.54 ± 0.01	0.71 ± 0.05	0.97 ± 0.08	1.45 ± 0.34	2.56 ± 0.34	1.01 ± 0.08	0.93 ± 0.31
Forages:								
Parsley	2	0.69 ± 0.17	0.91 ± 0.16	0.93 ± 0.34	2.97 ± 1.22	2.51 ± 0.56	1.22 ± 0.47	0.93 ± 0.32
Vegetables:								
Cabbage	2	0.55 ± 0.25	0.59 ± 0.14	0.75 ± 0.31	1.37 ± 0.23	2.03 ± 0.35	0.87 ± 0.22	0.78 ± 0.34

n: number of feed samples. Ser: serine, Gly: glycine, Asp: aspartic acid, Glu: glutamine, Ala: alanine, Pro: proline, Tyr: tyrosine.

Mineral composition (on a DM basis) of selected feedstuffs available on small-scale urban pig farms

In summer, spinach contained the highest concentrations of magnesium (8.16 g/kg), potassium (44.6 g/kg), calcium (10.5 g/kg), and sulphur (0.86 g/kg), while Russian sausages and the soybean and milk mix contained the highest concentrations of sodium (29.2 g/kg) and phosphorus (7.8 g/kg), respectively (Table 5a). The lowest concentrations were observed in prickly pear (sodium: 0.02 g/kg), Russian sausage (magnesium: 0.42 g/kg), pineapple (phosphorous: 0.6 g/kg), kitchen swill (potassium: 4.25 g/kg), potatoes (calcium: 0.4 g/kg), and cabbage and carrot stir-fry, prickly pear, cauliflower, and potatoes (sulphur: 0.03 g/kg) (Table 5a). For winter samples, the highest concentrations of macrominerals were observed in pizza dough (sodium: 28.8 g/kg), wheat bran (magnesium: 5.25 g/kg, phosphorous: 12.9 g/kg), tomatoes (potassium: 43.3 g/kg), parsley (calcium: 23 g/kg), and watermelon (sulphur: 0.78 g/kg). The lowest concentrations were observed in butternut (sodium: 0.11 g/kg), ice cream and cheese mix (magnesium: 0.39 g/kg, potassium: 1.78 g/kg), watermelon (phosphorous: 2.06 g/kg), yellow maize (calcium: 0.11 g/kg), and gooseberries (sulphur: 0.02 g/kg) (Table 6a).

In summer, spinach contained high concentrations of microminerals such as boron (43.3 mg/kg), aluminium (688 mg/kg), and iron (650 mg/kg), while copper (38.3 mg/kg) and zinc (203 mg/kg) were present at relatively high concentrations in grower pellets. Other feedstuffs containing relatively high concentrations of microminerals were eggplants (chromium: 9.94 mg/kg), weaner pellets (manganese: 83.1 mg/kg), cabbage and carrot stir-fry (nickel: 14.9 mg/kg), milk whey pellets (strontium: 67.1 mg/kg), and prickly pears (barium: 22.5 mg/kg) (Table 5b). The lowest concentrations of boron (0.76 mg/kg), manganese (1.07 mg/kg), nickel (0.3 mg/kg), and copper (2.15 mg/kg) were observed in Russian sausage samples. The lowest micromineral concentrations were found in red fig (chromium: 0.38 mg/kg, iron: 31.7 mg/kg), pineapple (zinc: 5.84 mg/kg), and potatoes (strontium: 3.79 mg/kg, barium: 0.48 mg/kg) (Table 5b). In winter, the wheat pollard and fishmeal mix contained exceptionally high concentrations of aluminium (2513 mg/kg), iron (3079 mg/kg), and nickel (11.2 mg/kg), relative to the other feedstuffs (Table 6b). Boron (32.6 mg/kg) and chromium (33.5 mg/kg) were prevalent in watermelon, manganese (143 mg/kg) and barium (16.7 mg/kg) in wheat bran, copper (48.3 mg/kg) in grower pellets, zinc (449 mg/kg) in stewed beef, and strontium (215 mg/kg) in cabbage (Table 6b). The ice cream and cheese mix contained the lowest concentrations of boron (1.27 mg/kg), manganese (1.61 mg/kg), iron (33.6 mg/kg), and copper (0.62 mg/kg). Aluminium (8.8 mg/kg), chromium (0.17 mg/kg), strontium (0.7 mg/kg), and barium (0.07 mg/kg) concentrations were lowest in yellow maize (Table 6). For nickel (0.2 mg/kg) and zinc (16.1 mg/kg), the lowest concentrations were reported in wraps and carrot soup, respectively (Table 6b). Table 7 shows the amino acid and macro- and micromineral requirements of piglets, growing pigs, and sows (NRC, 2012).

Generally, all the feedstuffs could meet the macromineral demands of all the pig types, with the exception of fruits in both seasons, which were low in sodium and calcium, as is common among fruits (Ramona Cristina *et al.*, 2014; de Assis *et al.*, 2022). Thus, pig producers in the study area must combine fruits with high sodium and calcium-containing feedstuffs, such as kitchen waste, during the summer when fruits are predominantly fed. The exceptionally high sodium content in Russian sausage waste and pizza dough in both seasons was not surprising, because salt (sodium chloride) is usually used as a preservative, binder, tenderiser, and colour and flavour enhancer in processed products (Peters *et al.*, 2017; Kim *et al.*, 2021). The high calcium and phosphorous concentrations in pizza dough could be ascribed to the macrominerals concentrated in wheat and the heat treatment applied during processing (Stein *et al.*, 2016). Sulphur is rarely addressed in diet formulation because it is largely incorporated as a component of the amino acids methionine and cysteine. Hence, there is no known sulphur requirement, *per se*, for pigs (Lewis & Southern, 2001).

Overall, all the feedstuffs could meet the iron and manganese requirements of all types of pigs in both seasons. However, only the commercial feeds had copper contents exceeding the requirements of lactating pigs. The exceptionally high iron concentrations observed in spinach and the wheat pollard and fishmeal mix make these feedstuffs ideal for piglets, particularly those weighing 5–7 kg and requiring ca. 26 g iron/day (NRC, 2012). Newborn piglets have low iron reserves of only 35–50 mg, and have a daily demand of 7–16 mg/day, whereas sow's milk only provides 1 mg iron/L (NRC, 2012). The high zinc requirements of all types of pigs could also only be met by commercial feeds and soybean meal in both seasons, whereas in winter, it could be met by wheat bran, pizza dough, stewed beef, and parsley. Stewed beef is an excellent source of zinc, as meat is a naturally better source of zinc than milk and plants are (Djinovic-Stojanovic *et al.*, 2017).

Table 5a Macromineral composition (mean ± standard deviation, in g/kg dry matter) of locally available pig feedstuffs sampled during summer in the Cape Metropole, South Africa

Feedstuffs	n	Na	Mg	P	K	Ca	S
Commercial feeds:							
Grower pellets	2	1.58 ± 0.12	2.07 ± 0.82	4.95 ± 0.52	8.19 ± 0.45	7.29 ± 1.25	0.38 ± 0.05
Milk whey pellets	2	1.98 ± 0.16	2.23 ± 0.94	5.70 ± 0.71	8.13 ± 0.32	8.95 ± 1.48	0.46 ± 0.07
Weaner pellets	2	1.98 ± 0.16	1.83 ± 0.12	5.28 ± 0.64	8.25 ± 0.63	7.60 ± 1.30	0.39 ± 0.06
Legume grains:							
Soybean meal	2	9.60 ± 1.26	1.39 ± 0.10	3.13 ± 0.11	7.60 ± 1.65	1.57 ± 0.56	0.22 ± 0.04
Kitchen wastes:							
Cabbage + carrot stir-fry	2	7.18 ± 3.92	2.05 ± 0.23	3.92 ± 0.13	22.9 ± 2.10	5.11 ± 0.99	0.03 ± 0.00
Kitchen swill	3	6.17 ± 2.46	0.66 ± 0.02	2.54 ± 0.09	4.25 ± 1.11	6.01 ± 2.64	0.21 ± 0.22
Russian sausage	2	29.2 ± 4.36	0.42 ± 0.01	6.00 ± 0.52	5.19 ± 1.14	1.93 ± 0.50	0.20 ± 0.01
Homemade mixed diets:							
Soybean + milk mix	2	1.19 ± 0.96	2.22 ± 0.22	7.80 ± 1.30	17.6 ± 2.34	5.23 ± 0.10	0.05 ± 0.00
Fruits:							
Eggplant	2	0.64 ± 0.32	1.64 ± 0.08	3.20 ± 0.30	22.0 ± 2.88	2.12 ± 0.08	0.26 ± 0.01
Green pepper	2	0.32 ± 0.12	1.73 ± 0.09	3.74 ± 0.43	28.0 ± 3.22	1.55 ± 0.06	0.21 ± 0.01
Pineapple	2	0.05 ± 0.01	0.92 ± 0.10	0.60 ± 0.02	20.4 ± 2.54	0.79 ± 0.04	0.48 ± 0.06
Prickly pear	2	0.02 ± 0.00	3.62 ± 0.20	1.10 ± 0.09	12.4 ± 1.35	9.36 ± 1.28	0.03 ± 0.00
Pumpkin	2	0.27 ± 0.11	2.01 ± 0.13	5.04 ± 1.95	35.4 ± 1.93	2.30 ± 0.11	0.54 ± 0.13
Red fig	2	0.05 ± 0.01	1.30 ± 0.08	1.15 ± 0.08	10.8 ± 0.98	2.77 ± 0.21	0.39 ± 0.01
Squash	2	0.05 ± 0.01	3.33 ± 0.25	6.07 ± 0.60	37.7 ± 3.20	1.50 ± 0.18	0.51 ± 0.02
Tomatoes	2	0.24 ± 0.02	1.83 ± 0.09	4.66 ± 0.29	30.9 ± 3.44	2.82 ± 0.84	0.07 ± 0.01
Vegetables:							
Cauliflower	2	1.61 ± 0.10	1.60 ± 0.08	5.75 ± 0.42	35.9 ± 3.55	2.87 ± 0.95	0.03 ± 0.00
Green beans	2	0.06 ± 0.01	2.59 ± 0.30	4.30 ± 0.42	27.9 ± 2.84	4.96 ± 1.57	0.39 ± 0.06
Potatoes	2	1.44 ± 0.25	1.01 ± 0.06	3.21 ± 0.40	23.8 ± 2.52	0.40 ± 0.03	0.03 ± 0.00
Spinach	2	14.7 ± 2.66	8.16 ± 1.96	5.73 ± 0.54	44.6 ± 3.21	10.5 ± 1.38	0.86 ± 0.09

n: number of feed samples. Na: sodium, Mg: magnesium, P: phosphorus, K: potassium, Ca: calcium, S: sulphur.

Table 5b Micromineral composition (mean ± standard deviation, in mg/kg dry matter) of locally available pig feedstuffs sampled during summer in the Cape Metropole, South Africa

Feedstuffs	n	B	Al	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Ba
Commercial feeds:											
Grower pellets	2	14.1 ± 1.23	62.8 ± 5.36	5.53 ± 1.30	100 ± 6.25	295 ± 14.1	1.82 ± 0.11	38.3 ± 3.22	203 ± 9.36	56.0 ± 5.58	5.35 ± 1.54
Milk whey pellets	2	14.4 ± 1.25	151 ± 8.96	1.53 ± 0.20	81.1 ± 4.62	323 ± 16.4	2.14 ± 0.23	18.7 ± 2.34	132 ± 1.20	67.1 ± 6.54	4.33 ± 1.00
Weaner pellets	2	17.6 ± 1.67	118 ± 21.6	2.39 ± 0.74	83.1 ± 7.78	286 ± 36.5	2.52 ± 0.93	125 ± 13.3	152 ± 4.21	54.0 ± 5.11	4.98 ± 1.02
Legume grains:											
Soybean meal	2	12.9 ± 1.12	112 ± 6.35	1.84 ± 0.38	24.6 ± 3.41	292 ± 9.35	3.23 ± 0.52	6.96 ± 1.21	91.9 ± 8.23	8.77 ± 2.31	4.28 ± 0.95
Kitchen wastes:											
Cabbage + carrot stir-fry	2	27.2 ± 2.20	380 ± 8.96	3.07 ± 0.59	19.2 ± 2.14	92.7 ± 7.74	14.9 ± 2.55	11.9 ± 2.47	29.1 ± 4.63	39.2 ± 2.86	11.2 ± 1.86
Kitchen swill	3	17.4 ± 5.18	270 ± 37.57	4.37 ± 1.04	14.3 ± 2.55	184 ± 15.0	2.01 ± 2.08	8.70 ± 3.87	23.9 ± 6.24	28.0 ± 1.38	4.70 ± 1.35
Russian sausage	2	0.76 ± 0.09	15.2 ± 2.14	0.54 ± 0.06	1.07 ± 0.09	45.9 ± 6.13	0.30 ± 0.03	2.15 ± 0.85	41.9 ± 4.51	8.44 ± 1.45	0.63 ± 0.09
Homemade mixed diets:											
Soybean + milk mix	2	23.6 ± 2.40	28.2 ± 3.54	1.15 ± 0.71	29.5 ± 3.57	129 ± 10.3	6.33 ± 0.45	16.1 ± 2.44	56.9 ± 5.25	6.82 ± 1.20	5.87 ± 1.62
Fruits:											
Eggplant	2	19.9 ± 2.13	327 ± 10.1	9.94 ± 1.85	24.6 ± 3.48	342 ± 15.0	13.2 ± 2.33	8.12 ± 1.54	32.9 ± 4.48	14.3 ± 2.36	2.05 ± 0.49
Green pepper	2	18.3 ± 2.54	212 ± 7.88	4.72 ± 0.86	17.5 ± 3.26	235 ± 12.5	3.25 ± 0.82	10.9 ± 1.74	29.6 ± 3.14	9.28 ± 1.57	2.01 ± 0.14
Pineapple	2	7.43 ± 1.47	199 ± 9.22	1.19 ± 0.30	26.0 ± 2.29	52.8 ± 5.36	4.90 ± 0.96	5.21 ± 0.20	5.84 ± 0.80	6.85 ± 0.98	2.22 ± 0.42
Prickly pear	2	21.1 ± 2.69	52.9 ± 3.45	1.18 ± 0.09	195 ± 12.6	49.9 ± 4.56	3.31 ± 0.56	4.31 ± 0.59	15.5 ± 2.45	63.4 ± 5.26	22.5 ± 4.32
Pumpkin	2	30.7 ± 3.63	172 ± 29.09	1.86 ± 1.66	17.4 ± 4.52	80.1 ± 14.9	2.59 ± 0.23	7.04 ± 1.67	30.8 ± 4.14	24.4 ± 5.16	3.83 ± 2.30
Red fig	2	22.4 ± 3.15	41.9 ± 4.52	0.38 ± 0.06	8.94 ± 1.80	31.7 ± 4.23	1.10 ± 0.15	2.58 ± 0.42	7.27 ± 1.85	30.4 ± 3.75	6.45 ± 1.42
Squash	2	22.7 ± 3.19	9.67 ± 2.16	8.77 ± 1.32	14.4 ± 2.32	249 ± 8.56	5.87 ± 0.78	10.0 ± 2.56	31.9 ± 2.45	12.4 ± 52.0	1.75 ± 0.94
Tomatoes	2	14.4 ± 2.78	246 ± 8.52	1.69 ± 0.15	24.1 ± 3.46	165 ± 5.69	1.23 ± 0.08	5.71 ± 1.05	21.1 ± 2.10	20.5 ± 3.74	0.82 ± 0.08
Vegetables:											
Cauliflower	2	20.6 ± 3.45	28.2 ± 2.54	2.14 ± 0.53	10.4 ± 1.28	91.8 ± 3.99	1.77 ± 0.10	6.20 ± 1.60	33.2 ± 2.45	16.3 ± 2.99	2.20 ± 0.05
Green beans	2	18.3 ± 315	76.6 ± 5.41	0.76 ± 0.08	44.6 ± 3.56	103 ± 7.65	2.31 ± 0.15	10.1 ± 1.52	34.4 ± 2.84	26.5 ± 3.52	4.87 ± 0.98
Potatoes	2	10.2 ± 3.67	109 ± 6.34	0.56 ± 0.06	4.9 ± 0.94	53.0 ± 3.46	1.55 ± 0.09	4.61 ± 0.95	23.3 ± 2.10	3.79 ± 0.84	0.48 ± 0.05
Spinach	2	43.3 ± 4.12	688 ± 12.9	2.40 ± 0.14	58.4 ± 4.25	650 ± 20.1	2.14 ± 0.01	13.9 ± 2.15	68.2 ± 4.28	38.9 ± 4.12	13.6 ± 2.16

n: number of feed samples. B: boron, Al: aluminium, Cr: chromium, Mn: manganese, Fe: iron, Ni: nickel, Cu: copper, Zn: zinc, Sr: strontium, Ba: barium.

Table 6a Macromineral composition (mean ± standard deviation, in g/kg dry matter) of locally available pig feedstuffs sampled during winter in the Cape Metropole, South Africa

Feedstuffs	n	Na	Mg	P	K	Ca	S
Cereal by-products:							
Wheat bran	2	0.16 ± 0.08	5.25 ± 0.48	12.9 ± 3.60	16.1 ± 1.65	1.27 ± 0.82	0.29 ± 0.07
Commercial feeds:							
Grower pellets	6	2.50 ± 1.30	2.20 ± 0.37	4.83 ± 1.61	10.0 ± 1.13	7.70 ± 2.53	0.70 ± 0.20
Milk whey pellets	2	2.14 ± 0.10	2.12 ± 0.28	5.50 ± 1.48	9.44 ± 0.97	9.99 ± 1.65	0.63 ± 0.06
Commercial feed	2	1.95 ± 0.09	1.57 ± 0.06	12.4 ± 3.52	8.79 ± 0.64	18.6 ± 2.32	0.22 ± 0.05
Starter pellets	2	4.03 ± 0.25	2.23 ± 0.30	4.97 ± 1.72	9.96 ± 0.88	5.53 ± 0.89	0.76 ± 0.04
Weaner pellets	2	1.67 ± 0.08	2.01 ± 0.25	6.37 ± 1.80	9.45 ± 0.32	8.05 ± 1.42	0.40 ± 0.01
Legume grains:							
Soybean meal	2	13.8 ± 2.34	1.71 ± 0.09	4.12 ± 1.65	11.5 ± 1.10	2.42 ± 0.84	0.38 ± 0.09
Cereal grains:							
Yellow maize	2	0.13 ± 0.05	1.03 ± 0.09	3.07 ± 1.23	3.82 ± 0.50	0.11 ± 0.08	0.04 ± 0.00
Bakery by-products:							
Pizza dough	2	28.8 ± 3.74	0.47 ± 0.04	1.98 ± 0.52	4.29 ± 0.56	0.98 ± 0.32	0.15 ± 0.05
Dairy by-products:							
Ice cream + cheese mix	2	19.5 ± 2.45	0.39 ± 0.02	6.80 ± 1.77	1.78 ± 0.09	9.73 ± 1.50	0.06 ± 0.00
Kitchen wastes:							
Carrot soup	2	16.7 ± 2.15	0.48 ± 0.05	0.97 ± 0.92	7.46 ± 0.52	1.31 ± 0.63	0.08 ± 0.00
Kitchen swill	2	9.70 ± 2.57	0.80 ± 0.12	3.00 ± 0.32	8.90 ± 2.68	3.30 ± 1.10	0.50 ± 0.31
Stewed beef	2	11.2 ± 2.35	0.90 ± 0.10	4.94 ± 1.62	17.7 ± 1.59	3.80 ± 0.35	0.61 ± 0.02
Vegetable stir-fry	2	1.77 ± 0.36	1.61 ± 0.12	4.42 ± 1.36	30.9 ± 2.51	3.55 ± 1.82	0.16 ± 0.01
Wraps	2	11.4 ± 1.52	0.69 ± 0.08	3.64 ± 1.11	6.40 ± 0.56	2.81 ± 0.52	0.06 ± 0.00
Homemade mixed diets:							
Bread + vegetables	2	6.77 ± 0.92	0.94 ± 0.11	2.74 ± 0.10	8.18 ± 0.21	1.80 ± 0.35	0.13 ± 0.04
Soybean + fish meal	2	2.74 ± 0.18	1.75 ± 0.20	10.0 ± 2.63	11.1 ± 1.35	11.8 ± 1.71	0.24 ± 0.06

n: number of feed samples. Na: sodium, Mg: magnesium, P: phosphorus, K: potassium, Ca: calcium, S: sulphur.

Table 6a (continued)

Feedstuffs	n	Na	Mg	P	K	Ca	S
Homemade mixed diets (continued):							
Maize meal + bread flour mix	2	2.79 ± 0.56	2.10 ± 0.52	4.52 ± 1.77	9.17 ± 1.54	4.45 ± 0.45	0.84 ± 0.06
Pollard + fishmeal mix	2	2.62 ± 0.52	2.08 ± 0.68	6.18 ± 1.88	10.3 ± 1.86	7.87 ± 1.01	0.71 ± 0.06
Forages:							
Parsley	2	5.20 ± 0.79	4.20 ± 1.22	6.40 ± 0.91	50.4 ± 6.30	23.0 ± 4.26	0.60 ± 0.02
Fruits:							
Butternut	2	0.11 ± 0.08	3.16 ± 0.76	3.48 ± 1.36	31.0 ± 2.45	4.59 ± 0.95	0.69 ± 0.02
Gooseberries	2	0.14 ± 0.09	1.94 ± 0.59	3.86 ± 0.86	22.2 ± 2.10	0.63 ± 0.13	0.02 ± 0.00
Red pepper	2	0.22 ± 0.09	1.45 ± 0.13	3.26 ± 0.69	28.1 ± 3.18	1.30 ± 0.06	0.08 ± 0.00
Tomatoes	2	0.81 ± 0.10	2.03 ± 0.25	4.38 ± 0.12	43.3 ± 3.87	2.97 ± 0.52	0.09 ± 0.00
Watermelon	2	0.82 ± 0.10	2.04 ± 0.25	2.06 ± 0.09	26.8 ± 2.82	4.55 ± 0.84	0.78 ± 0.21
Vegetables:							
Cabbage	2	3.30 ± 0.52	3.00 ± 1.35	5.00 ± 2.04	31.9 ± 12.1	25.4 ± 15.1	0.20 ± 0.21
Carrots	2	9.80 ± 3.78	2.10 ± 0.22	4.30 ± 0.30	33.8 ± 4.32	6.10 ± 2.88	0.30 ± 0.16
Greek salad	2	2.48 ± 0.46	1.94 ± 0.08	5.75 ± 0.90	35.1 ± 5.12	4.11 ± 0.84	0.48 ± 0.09
Onions	2	0.65 ± 0.04	1.54 ± 0.14	6.59 ± 0.99	28.8 ± 4.26	3.42 ± 0.36	0.17 ± 0.06

n: number of feed samples. Na: sodium, Mg: magnesium, P: phosphorus, K: potassium, Ca: calcium, S: sulphur.

Table 6b Micromineral composition (mean ± standard deviation, in mg/kg dry matter) of locally available pig feedstuffs sampled during winter in the Cape Metropole, South Africa

Feedstuffs	n	B	Al	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Ba
Cereal by-products:											
Wheat bran	2	3.68 ± 0.61	27.7 ± 2.65	0.53 ± 0.05	143 ± 12.4	141 ± 10.2	0.68 ± 0.05	9.50 ± 1.84	85.2 ± 8.22	19.6 ± 2.41	16.7 ± 2.52
Commercial feeds:											
Grower pellets	6	10.6 ± 3.05	203 ± 115	3.30 ± 2.56	76.2 ± 20.2	353 ± 77.7	3.00 ± 1.04	48.3 ± 0.64	227 ± 2.19	40.2 ± 13.5	6.20 ± 1.88
Milk whey pellets	2	10.5 ± 2.14	159 ± 9.68	2.03 ± 0.36	106 ± 9.62	348 ± 14.1	3.33 ± 0.56	27.8 ± 2.54	138 ± 3.51	62.3 ± 4.25	5.44 ± 1.45
Commercial feed	2	14.4 ± 2.42	99.7 ± 8.26	3.44 ± 0.95	21.8 ± 2.32	193 ± 9.42	1.47 ± 0.08	6.10 ± 2.30	43.5 ± 4.55	106 ± 9.35	3.78 ± 0.96
Starter pellets	2	16.1 ± 3.10	219 ± 11.4	2.35 ± 0.06	95.0 ± 5.23	392 ± 15.3	2.11 ± 0.24	30.6 ± 3.10	219 ± 8.25	30.6 ± 4.85	7.13 ± 0.88
Weaner pellets	2	14.4 ± 2.03	138 ± 13.2	1.81 ± 0.04	87.6 ± 4.28	289 ± 10.8	3.93 ± 0.54	134 ± 12.4	185 ± 7.36	45.9 ± 4.72	4.91 ± 0.68
Legume grains:											
Soybean meal	2	13.9 ± 2.30	219 ± 13.4	9.55 ± 1.72	32.0 ± 2.21	478 ± 19.5	9.33 ± 1.03	7.23 ± 1.78	81.5 ± 5.22	14.0 ± 2.46	6.30 ± 0.84
Cereal grains:											
Yellow maize	2	3.91 ± 0.84	8.80 ± 1.84	0.17 ± 0.02	5.26 ± 0.82	41.7 ± 4.61	0.24 ± 0.08	2.37 ± 0.23	17.2 ± 2.43	0.70 ± 0.08	0.07 ± 0.00
Bakery by-products:											
Pizza dough	2	3.43 ± 0.80	265 ± 9.44	2.83 ± 0.62	8.68 ± 1.64	178 ± 7.62	1.88 ± 0.23	2.91 ± 0.31	116 ± 10.5	7.21 ± 1.99	1.27 ± 0.05
Dairy by-products:											
Ice cream + cheese mix	2	1.27 ± 0.05	65.4 ± 4.21	0.63 ± 0.02	1.61 ± 0.09	33.6 ± 5.26	0.29 ± 0.06	0.62 ± 0.30	55.1 ± 4.51	9.97 ± 2.47	1.11 ± 0.09
Kitchen wastes:											
Carrot soup	2	8.53 ± 1.45	158 ± 13.5	1.20 ± 0.23	5.76 ± 0.58	47.9 ± 4.68	0.44 ± 0.03	1.17 ± 0.96	16.1 ± 3.54	13.9 ± 2.48	4.64 ± 0.88
Kitchen swill	2	6.30 ± 0.50	438 ± 370.6	5.60 ± 2.86	13.4 ± 2.67	328 ± 159	2.80 ± 1.11	6.90 ± 5.11	28.6 ± 3.36	19.4 ± 11.9	2.90 ± 0.73
Stewed beef	2	4.84 ± 0.98	82.2 ± 8.52	2.13 ± 0.36	7.93 ± 1.20	94.6 ± 6.74	0.99 ± 0.08	3.64 ± 0.93	449 ± 12.9	9.86 ± 1.30	2.33 ± 0.58
Vegetable stir-fry	2	19.9 ± 2.46	130 ± 18.5	0.63 ± 0.13	17.3 ± 2.65	78.7 ± 5.32	1.85 ± 0.10	4.36 ± 0.58	29.8 ± 3.44	27.5 ± 3.84	1.92 ± 0.08
Wraps	2	1.93 ± 0.63	15.1 ± 2.81	0.33 ± 0.10	4.24 ± 0.86	32.5 ± 4.10	0.20 ± 0.06	1.99 ± 0.23	15.4 ± 2.14	4.38 ± 0.84	1.03 ± 0.01
Homemade mixed diets:											
Bread + vegetables	2	6.94 ± 1.04	30.1 ± 3.25	1.02 ± 0.09	16.9 ± 2.45	111 ± 5.62	0.86 ± 0.06	3.24 ± 0.64	34.7 ± 3.25	11.5 ± 2.03	2.16 ± 0.06

n: number of feed samples. B: boron, Al: aluminium, Cr: chromium, Mn: manganese, Fe: iron, Ni: nickel, Cu: copper, Zn: zinc, Sr: strontium, Ba: barium.

Table 6b (continued)

Feedstuffs	n	B	Al	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Ba
Homemade mixed diets (continued):											
Soybean + fish meal	2	13.8 ± 2.34	52.3 ± 4.56	2.04 ± 0.12	17.3 ± 3.15	258 ± 8.25	1.72 ± 0.09	8.10 ± 1.74	54.3 ± 4.12	41.2 ± 3.02	5.13 ± 0.82
Maize meal + bread flour	2	3.35 ± 0.54	625 ± 17.4	4.05 ± 0.92	94.9 ± 6.31	714 ± 15.9	2.38 ± 0.12	8.33 ± 1.37	138 ± 9.64	14.7 ± 2.85	7.60 ± 1.08
Pollard + fishmeal	2	8.82 ± 1.54	2513 ± 25.1	21.9 ± 0.27	80.7 ± 4.12	3079 ± 30.2	11.2 ± 1.06	6.85 ± 0.89	46.6 ± 4.21	44.2 ± 4.36	17.7 ± 2.35
Forages:											
Parsley	2	28.2 ± 7.55	378 ± 26.3	17.3 ± 8.84	37.5 ± 12.6	482 ± 172	7.90 ± 4.02	6.60 ± 0.11	105 ± 70.78	124 ± 68.1	4.80 ± 1.30
Fruits:											
Butternut	2	20.3 ± 3.15	24.5 ± 3.66	1.19 ± 0.36	11.3 ± 1.03	79.3 ± 4.32	1.88 ± 0.18	8.84 ± 1.86	26.3 ± 3.26	32.7 ± 3.45	2.63 ± 0.26
Gooseberries	2	9.97 ± 1.48	38.9 ± 4.65	0.43 ± 0.09	11.2 ± 1.88	61.7 ± 3.27	0.67 ± 0.06	7.96 ± 1.41	23.4 ± 2.91	4.03 ± 1.26	1.47 ± 0.12
Red pepper	2	12.9 ± 2.47	179 ± 8.52	0.43 ± 0.08	11.2 ± 1.94	83.5 ± 5.26	0.61 ± 0.02	10.1 ± 2.84	23.4 ± 2.86	7.07 ± 0.84	1.37 ± 0.10
Tomatoes	2	17.2 ± 3.69	234 ± 11.6	0.58 ± 0.06	15.9 ± 2.01	104 ± 9.06	0.52 ± 0.01	8.16 ± 1.37	37.1 ± 3.64	12.6 ± 1.42	2.06 ± 0.26
Watermelon	2	32.6 ± 4.88	660 ± 20.2	33.5 ± 3.48	15.4 ± 2.30	108 ± 6.85	16.5 ± 2.44	4.48 ± 0.94	33.5 ± 3.30	33.9 ± 3.27	6.76 ± 0.17
Vegetables:											
Cabbage	2	25.5 ± 0.76	85.8 ± 44.9	3.07 ± 0.36	23.9 ± 17.8	147 ± 7.50	1.40 ± 0.24	2.70 ± 0.38	44.9 ± 8.87	215 ± 178	1.30 ± 0.44
Carrots	2	29.6 ± 4.04	253 ± 23.0	14.6 ± 3.22	18.6 ± 11.9	319 ± 27.3	6.70 ± 2.19	6.90 ± 3.37	38.0 ± 2.66	7.7 ± 20.2	7.50 ± 3.15
Greek salad	2	19.5 ± 3.22	309 ± 15.2	8.41 ± 2.88	22.5 ± 3.92	199 ± 16.5	3.83 ± 0.85	6.11 ± 3.35	41.8 ± 3.66	24.6 ± 2.35	1.86 ± 0.19
Onions	2	23.9 ± 4.36	127 ± 8.52	6.37 ± 1.78	18.5 ± 2.42	181 ± 12.2	3.39 ± 0.78	5.61 ± 2.98	41.6 ± 3.64	25.8 ± 245	2.69 ± 028

n: number of feed samples. B: boron, Al: aluminium, Cr: chromium, Mn: manganese, Fe: iron, Ni: nickel, Cu: copper, Zn: zinc, Sr: strontium, Ba: barium.

Table 7 Nutrient requirements of various pig classes when allowed feed *ad libitum* (90% dry matter)

Nutrient	Piglets ≤11 kg	Growing pigs 25–50	Gestating sows[1] 140 kg	Lactating sows[2] 175 kg
Amino acids (%):				
Arginine	0.68–0.75	0.50	0.42	0.48
Histidine	0.53–0.58	0.39	0.27	0.35
Isoleucine	0.79–0.88	0.59	0.43	0.49
Leucine	1.54–1.71	1.13	0.75	0.96
Lysine	1.53–1.70	1.12	0.80	0.86
Methionine	0.44–0.49	0.32	0.23	0.23
Phenylalanine	0.91–1.01	0.68	0.44	0.47
Threonine	0.95–1.05	0.72	0.58	0.58
Tryptophan	0.25–0.28	0.19	0.15	0.15
Valine	1.00–1.10	0.75	0.58	0.16
Macrominerals (g/kg diet):				
Calcium	8.0–8.5	6.6	8.3	6.3
Phosphorus	6.5–7.0	5.6	6.2	5.6
Sodium	3.5–4.0	1.0	1.5	2.0
Chloride	4.5–5.0	0.8	1.2	1.6
Magnesium	0.4	0.4	0.6	0.6
Potassium	2.8–3.0	2.3	2.0	2.0
Microminerals (mg/kg diet):				
Copper	6.0	4.0	10	20
Iron	100	60	80	80
Manganese	4.0	2.0	25	25
Zinc	100	60	100	100

Source: National Research Council (2012). [1]Gestating sows: first parity and more than 90 days of gestation. [2]Lactating sows: first parity and post-farrowing body weight with a 21-day lactation length and mean daily weight gain of nursing pigs of 190 g.

Conclusions

Regardless of season, legume grains and vegetable, meat, and dairy waste-based feedstuffs contained high concentrations of protein, amino acids, and minerals. In contrast, kitchen wastes containing meat or dairy by-products and bakery wastes containing legume seeds had great potential as energy sources for pigs on small-scale urban farms. It was concluded that the identified locally available feedstuffs could be used to formulate farm-specific, low-cost, complete, and balanced homemade diets for pigs on the small-scale urban farms included in the study. Additional research should evaluate the safety and feeding value (i.e. effects on meat production and quality) of the identified feedstuffs on small-scale urban pig farms in developing countries. The main limitation of this study was the low number of replicates, which was due to challenges in collecting feed samples from resource-constrained small-scale farms. Thus, more longitudinal studies could be important to further elaborate on the finer temporal dynamics of feed availability.

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Authors' contributions

R.M.M.: Data curation, formal analysis, and writing – original draft preparation. F.S.: Data curation and writing – review and editing. O.C.C.: Data curation and writing – review and editing. C.L.F.K.: Data curation and writing – review and editing. A.H.M.: Supervision, writing – review and editing, and funding acquisition. M.C.M.: Supervision, writing – review and editing, and funding acquisition. P.E.S.: Supervision, writing – review and editing, and funding acquisition. C.M.: Conceptualisation, supervision, writing – review and editing, and funding acquisition. All authors have approved the final version of the manuscript.

Conflict of interest declaration

The authors have no conflicts of interest to declare.

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