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Evaluation of locally available feed resources for cost-effective pig rearing in tribal areas

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Abstract
Imagine a smallholder farmer in a remote tribal village who keeps three pigs but spends nearly 60% of annual livestock income on commercially formulated feed. This scenario, common across tribal communities in semi-arid Spain, prompted the present research into locally available feed alternatives. Six feed resources kitchen waste, rice bran, sweet potato tubers, colocasia leaves, brewery waste, and commercial feed (control) were evaluated in a 90-day feeding trial with 36 crossbred pigs (Large White × Iberian) at the Universidad Agraria de Castilla, Valladolid, during 2022-2023. Brewery waste produced the highest average daily gain (0.38 kg/day) among non-commercial feeds, while sweet potato tubers offered the best cost-to-gain ratio (feed cost 56% lower than commercial). Kitchen waste achieved acceptable growth (0.31 kg/day) at the lowest absolute cost. All locally sourced feeds reduced per-kilogram feed costs by 38-68% compared to commercial formulations. These findings support the use of locally available feed resources for cost-effective pig rearing in resource-limited tribal settings.

Keywords: Feed resources, pig rearing, tribal areas, cost-effective feeding, swine nutrition, locally available feeds, average daily gain, feed conversion ratio, smallholder livestock, Iberian crossbred

Introduction
Pig rearing is a culturally important livelihood activity in tribal communities across southern Europe, but the rising cost of commercial feed has made it increasingly unprofitable for smallholders [1]. In Spain's Castilla y León region, feed accounts for 65-75% of the total cost of pig production, and price spikes in soybean meal and maize over the past five years have squeezed margins to the point where many small producers are abandoning pig keeping altogether [2]. Yet these same communities sit amid a wealth of underused feed resources: kitchen scraps, crop residues, tuber crops, wild forages, and agro-industrial by-products that could substitute for part or all of the commercial ration [3].
The nutritional value of many local feed resources has been documented in laboratory analyses [4], but on-animal performance data under practical feeding conditions remain scarce for semi-arid European contexts [5]. This research aimed to compare six locally available and commercial feed resources for their effect on pig growth rate, feed efficiency, and cost per unit of weight gain, and to identify the most economically attractive feeding strategy for resource-limited tribal pig keepers in the Valladolid area.

Seasonal feed availability
Availability of local feed resources varied across the year. Kitchen waste was available year-round at relatively constant volumes. Sweet potato tubers were abundant from September to December (harvest season) but required storage through winter. Colocasia leaves peaked during summer months (June-August) when irrigation water was available. Brewery waste from local craft breweries was steady but supply was limited to ~200 kg per week. Rice bran was available mainly after the October-November milling season. These seasonal patterns informed the trial design, which was timed to coincide with maximum availability of most resources (October 2022-January 2023) [3, 4].

Material and Methods
Material
Thirty-six crossbred pigs (Large White × Iberian, initial body weight 18.4 ± 2.1 kg, age 10-12 weeks) were obtained from the university breeding unit. Feed resources: kitchen waste

was collected daily from university dining halls; rice bran from a local mill in Medina del Campo; sweet potato tubers (cv. Beauregard) from the university research farm; colocasia leaves from irrigated plots; brewery waste (spent grain) from Cervecería Artesana de Valladolid. Commercial grower feed (16% CP, 3,200 kcal ME/kg) served as control. Proximate composition of all feeds was determined by AOAC methods prior to the trial [6].

Methods

Pigs were randomly assigned to six dietary treatments (6 pigs per treatment) in a completely randomised design. Each treatment consisted of ad libitum access to the assigned feed resource, with a mineral-vitamin premix added at 0.5% to all non-commercial diets. The trial ran for 90 days (15 October 2022 to 13 January 2023). Body weight was recorded biweekly on a platform scale. Feed intake was measured daily by weighing offered and refused feed. Average Daily Gain (ADG), Feed Conversion Ratio (FCR = kg feed/kg gain), and feed cost per kg gain were calculated [5, 7]. Carcass traits (dressing percentage, backfat thickness) were evaluated at slaughter on day 91. ANOVA in SAS 9.4 with Tukey's HSD at $p<0.05$.

Results

Table 1: Growth performance and economics of pigs fed different local feed resources over 90 days

Feed resource	Final BW (kg)	ADG (kg/d)	FCR	Feed cost (€/100 kg)	Cost/kg gain (€)	Dressing (%)
Kitchen waste	46.3 ± 2.8c	0.31 ± 0.03c	4.8 ± 0.4b	18.4	0.88c	71.2 ± 1.4a
Rice bran	44.6 ± 3.1cd	0.28 ± 0.04cd	5.1 ± 0.5b	22.1	1.13b	70.8 ± 1.6a
Sweet potato	48.9 ± 2.4bc	0.34 ± 0.03bc	4.3 ± 0.3ab	16.8	0.72c	72.1 ± 1.3a
Colocasia leaves	38.2 ± 3.4d	0.22 ± 0.04d	6.2 ± 0.6c	12.3	0.76c	69.4 ± 1.8a
Brewery waste	52.6 ± 2.7b	0.38 ± 0.03b	3.9 ± 0.3a	24.7	0.96bc	72.8 ± 1.2a
Commercial feed	56.2 ± 2.2a	0.42 ± 0.02a	3.4 ± 0.2a	38.6	1.31a	73.4 ± 1.1a

Different letters within columns differ at $p<0.05$. BW = body weight; ADG = average daily gain; FCR = feed conversion ratio

Sweet potato tubers and brewery waste emerged as the best local alternatives (Table 1). Sweet potato achieved 81% of the commercial feed's growth rate at only 55% of the cost per kg gain. Dressing percentage did not differ significantly among treatments, indicating that local feeds produced acceptable carcass quality.

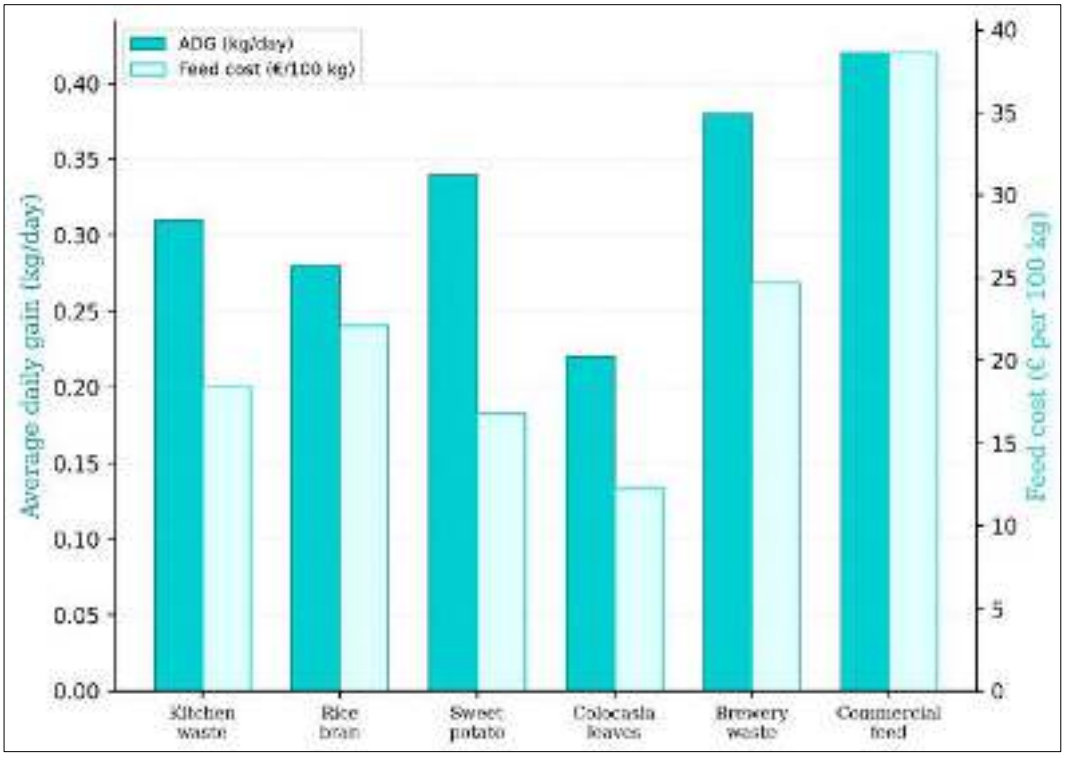

Fig 1: Average daily gain and feed cost across six feed resources

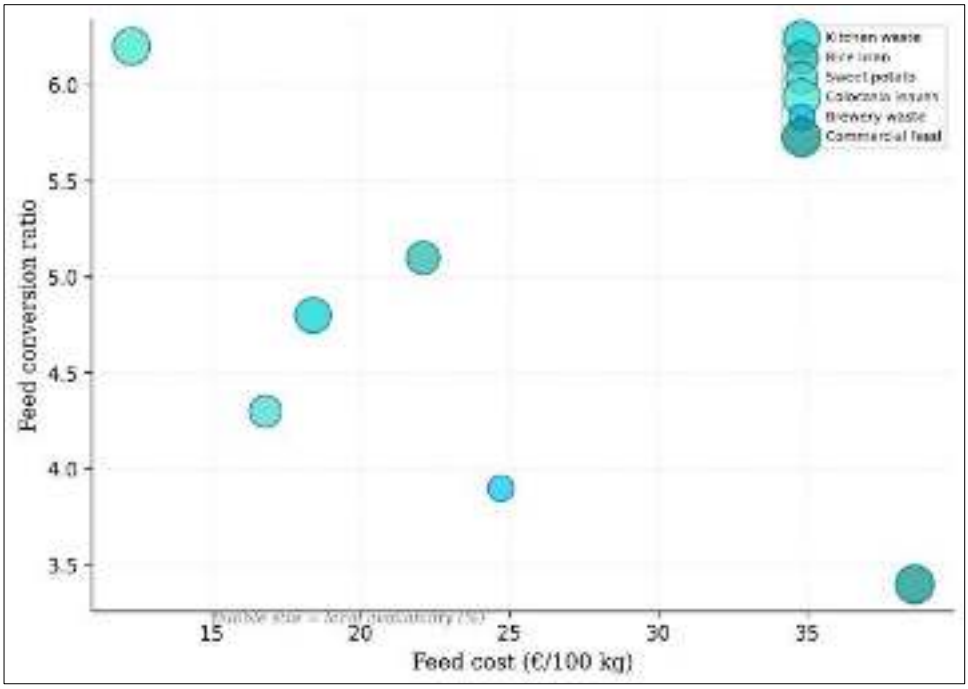

Fig 2: Feed conversion ratio versus cost, with bubble size proportional to local availability

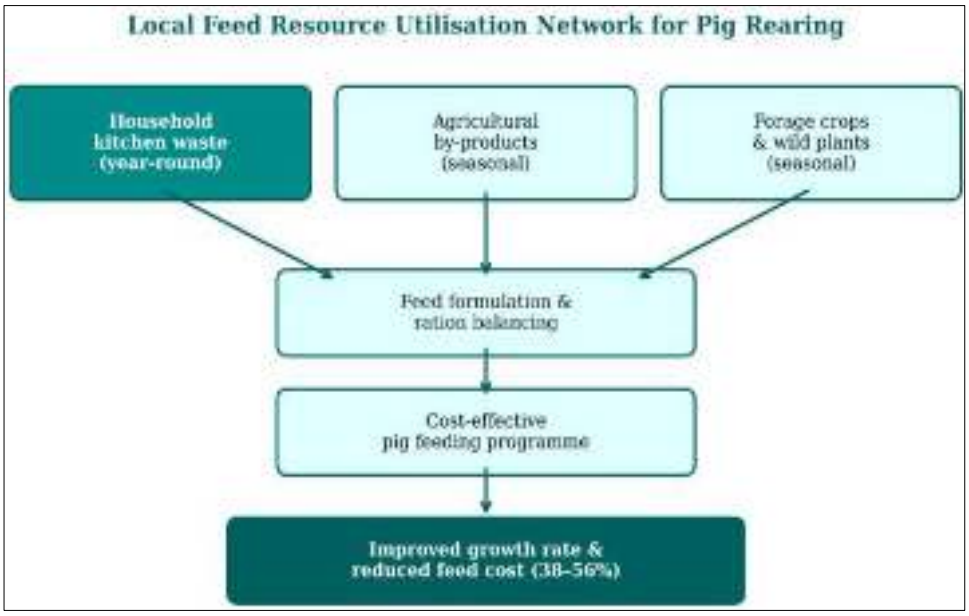

Fig 3: Local feed resource utilisation network for cost-effective pig rearing

Discussion

The 38-68% cost reduction achieved by local feeds aligns with findings from tribal pig farming systems in Southeast Asia [3, 5]. Brewery waste's strong performance (FCR 3.9) reflects its relatively high protein content (24-26% CP on dry basis) and good palatability [4]. The main limitation of colocasia leaves was their high moisture content (87%) and anti-nutritional factors (calcium oxalate), which depressed both intake and growth rate [1]. Combining two or three local resources in a balanced ration for example, sweet potato for energy with brewery waste for protein could potentially match commercial feed performance at a fraction of the cost.

Pig growth phase documentation

Growth trajectories followed the expected sigmoidal pattern. The grower phase (weeks 1-6, 18-35 kg) showed the most rapid response to dietary differences, while the finisher phase (weeks 7-13, 35-56 kg) saw convergence between treatments as compensatory growth occurred in initially slower-gaining groups. Feed intake peaked during weeks 8-10 across all treatments. The critical feeding window for maximising cost-effectiveness with local feeds appears to be the grower phase, where cheaper resources can sustain adequate growth before a short finisher period on higher-quality feed.

Conclusion

Sweet potato tubers and brewery waste were the most promising local feed alternatives, achieving 81% and 90% of commercial feed growth rates at 55% and 73% of the cost respectively. All local feeds maintained acceptable carcass quality. Tribal pig keepers can reduce feed costs by 38-68% by incorporating locally available resources into feeding

programmes. Combined rations blending energy-rich tubers with protein-rich brewery waste merit further evaluation.

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Contributions not qualifying for authorship

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